BREEDING PRACTICE AND ESTRUS SYNCHRONIZATION EVALUATION OF DAIRY CATTLE IN CENTRAL ZONE OF TIGRAY, NORTHERN ETHIOPIA

M.Sc. Thesis

DESTALEM GEBREMICHAEL

June, 2015

JIMMA UNIVERSITY

BREEDING PRACTICE AND ESTRUS SYNCHRONIZATION EVALUATION OF DAIRY CATTLE IN CENTRAL ZONE OF TIGRAY, NORTHERN ETHIOPIA

A Thesis Submitted to College of Agriculture and Veterinary Medicine School of Graduate Studies

JIMMA UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of MASTER OF SCIENCE IN AGRICULTURE (ANIMAL BREEDING AND GENETICS)

By

DESTALEM GEBREMICHAEL

June, 2015

Jimma University

APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

JIMMA UNIVERSITY

As *Thesis* research advisor, we hereby certify that we have read and evaluated this thesis prepared, under our guidance, by Destalem Gebremichael entitled " **Breeding Practice and Estrus Synchronization Evaluation of Dairy Cattle in Central Zone of Tigray, Northern Ethiopia**". We recommend that it be submitted as fulfilling the thesis requirement.

Co-Advisor	Signature	Date
Advisor	Signature	Date

As member of the board of examiners of the M.Sc. thesis open defense examination, we certify that we have read, evaluated the thesis prepared by Destalem Gebremichael and examined the candidate. We recommended that the thesis to be accepted as fulfilling the Thesis requirement for the Degree of Master of science in Animal Breeding and Genetics

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date

DEDICATION

I dedicate this thesis to my late father Gebremichael Beyene, my aunt medhin Beyene who pass away her life before a week of my External defense and my mother Letemichael Syum for their commitment in the success of my life.

STATEMENT OF AUTHOR

First, I declare that this thesis is my bona fide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirement for M. Sc. degree at the Jimma University College of agriculture and veterinary medicine and is deposited at the University library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any other academic degree, diploma, or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the Head of the Department of Animal Sciences or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in interests of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Destalem Gebremichael Signature______

Place: Jimma University, Jimma

Date of submission: ________________________

BIOGRAPHICAL SKETCH

The author, Destalem Gebremichael, was born in central zone of the Tigray Regional State, in October 1984. He began his education at Adekleyto Elementary School in Ahferom Wereda and completed his Elementary and Junior School at Gerhusrnay Junior School. He completed Secondary high School in Enticho Secondary and preparatory School (Enticho) in 2002/2003. He then joined Jimma University in 2003/2004 to attend his undergraduate study from where he graduated with a Bachelor Degree in Animal production and health in July 2006.

After completion of his undergraduate studies, he was employed by ‘Ganta-afeshum’ Bureau of Agriculture and rural development in Tigray regional state and served in the Department of Animal Production as animal production expert for 2 year and 7 month. After that he joined to Tigray Agricultural Research institution in 2009 and has been working as junior researcher in areas of animal nutrition at Axum Agricultural Research Center. After serving for three years in research, he joined again the School of Graduate Studies of Jimma University to pursue graduate studies in Animal Breeding and Genetics in September, 2013.

ACKNOWLEDGMENT

Above all, I thank the Almighty God for giving me health, strength and support for the completion of my study.

I would like to express my deep appreciation and thanks to my major adviser, Dr. Berhanu Belay and co adviser Dr. Azage Tegegne for their unreserved, continuous and all round support throughout my studies, including their scientific inputs.

My thanks are also owing to Pr. Kirmani manzor, for his utmost cooperation and assistance during the external defense and critical review of the thesis manuscript and precious suggestions.

I also gratefully acknowledge LIVES project (IRLI), for sponsoring the study and members of the project Dr. yaynshet Tesfay, Dr.Berhanu Gebremedhin, parmillia yestila, Tigst Endashaw and other staff members for their generous support during the study period.

I wish to express my sincere word of thanks to the Tigray Agricultural Research Institute (TARI) for giving me the chance to pursue M.Sc study. I am grateful to the staff of the Axum Agricultural Research Centre, particularly to all livestock core process members for their unlimited help and technical support. My further acknowledgement goes to the artificial insemination technicians and smallholder dairy farmers in Laelay michew, Adwa and Ahferom districts for their overall cooperation in synchronization and data collection.

Last but not the least, I appreciate my late father Gebremichael Beyene, my mother Letemichael Syum, my sisters and brothers Adeni kiros, Beriha Gebremichael, Abrehet Gebrekidan, Desalegn Gebrekiros and Gebrekiros Weldegebriael for their love, financial and moral support during my school stay. It is very difficult to make a whole list of individuals who helped to complete this study and it is preferred to express their sincere thanks to all of them.

ABBREVIATIONS and ACRONYMS

AFC	Age at First Calving
AI	Artificial Insemination
ANOVA	Analysis of variance
BSC	Body condition score
CI	Calving Interval
CL	Corpus Luteum
CR	Conception Rate
DAGRIS	Domestic Animal Genetic Resources Information System
DO	Days Open
EATA	Ethiopian agricultural transformation agency
FSH	Follicular Stimulating Hormone
GLM	General Linear Model
GnRH	Gonadotropin Releasing Hormone
IAEA	International Atomic Energy Agency
ILRI-IPMS	International Livestock Research Institute - Improving Productivity and Market Success of Ethiopian Farmers
IM	Intera Muscular
LH	Luteinizing Hormone``
LIVES	Livestock and Irrigation Value chains of Ethiopian Smallholders
mm	millimeter
Ng/ml	Nano gram per milliliter
NSC	Number of service per conception
$PGF_{2\alpha}$	Prostaglandin F2 alpha
PR	Pregnancy rate
RL	Reproductive Life
SAS	Statistical Analysis System

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES IN APPENDIX

ABSTRACT

The study was conducted in central zone, Tigray, Northern Ethiopia, aimed with assessment of breeding practices and evaluation of estrus synchronization of dairy cattle. The study of the survey covered 180 households found in per-urban and rural areas of Ahferom, Adwa and Laelay michew district which included 113 in rural areas and 67 in per-urban areas of the districts. The Information was collected from secondary data, group discussion, AI technician, household level survey questionnaire, farm visit and personal observations. Seven hundred one synchronized cows were selected form record of artificial insemination centre and evaluated for conception rate and number of service per conception. For experimental study a total of 126 dairy cattle 42 cows from each district were selected for PGF2α treatment. Single shot of $PGF_{2\alpha}$ *were given for dairy cattle that exhibited estrus after first injection and double shot has given to cows that failed to show heat after single injection. Twenty conceived lactating cows were used for progesterone profile assay using hormonost micro lab farmers test to check pregnancy and embryo mortality. The data were analyzed using SPSS (16) and SAS (9.1). Dairy cattle were kept for generating income (35.6%), milk consumption (32.2%) and milk consumption and breeding (*16.1%) in the study area*. Purchased dairy cattle (69.9% and 68.7%) were the main foundation stock followed by own (20.35% and 17.91%) in rural and per-urban areas respectively. Mating system in the study area were AI (42.8%), AI with estrus synchronization (22.2%) and natural mating (35%*). *Households obtained breeding bull from neighboring (61.4%), own (21.3%) and village (17.3%). Individual performance and pedigree selection were used as selection criteria for dairy cattle. Trait preference of farmers were milk yield (1*st*) body weight (2*nd*)) and fertility (3*rd*) for both rural and per-urban areas. Production system significantly affected daily milk yield of local cattle and cross dairy cattle. In the study area AFC (3.9± 0.8, 3.0± 0.9) years, CI (1.7± 0.4, 1.3 ±0.5) years and DO (10.9 ±0.5, 6.9± 0.62) months were for local and cross cattle respectively. Overall CR and NSC of mass synchronization were 37.95% and 2.63 respectively. BCS, bull and AI technician significantly affected CR and NSC in mass synchronization. From single injection in the experimental study 84.9% cows responded to PGF2α and 51.4% of them were conceived. 89.5% Cows show estrus sign and 52.9% conceived with double injection. Among 20 cows assumed to be pregnant on basis of milk progesterone concentration on day 18-24 post insemination, 85% were confirmed to be pregnant and 15% showed late embryonic death. Community based breeding program is the best option to improve dairy breeding practice in the study area. Improvements in facilities and management should be necessary before implementing an estrous synchronization program. Giving second injection for cows not responded for first injection of PGF2α has complimentary advantage to single injection. Progesterone assay using hormonost micro lab farmers test is a practical solution for dairy farmers to detect estrus, pregnancy and embryo mortality.*

Key words*: Dairy Cattle, Breeding Practice, Rural, Per-urban, Synchronization, Prostaglandin, Progesterone*

1. INTRODUCTION

Ethiopia has one of the largest livestock resources in Africa with a national herd estimated at 49 million cattle, 25 million sheep, 22 million goats and 9 million pack animals (EATA, 2013). Livestock support and sustain livelihoods for 80% of the rural community and 35 – 40 % of all livestock are located in the pastoral areas and female cattle constitute about 55.5% of the national herd (MoARD, 2007).

Livestock is raised in all of the farming systems of Ethiopia that included pastoralists, agro pastoralists, and crop-livestock mixed farmers. Dairy production systems can be broadly categorized into urban, per-urban and rural milk production systems based on scale of operation and market orientation (GebreWold *et al*, 2000).

A review of various dairy genotypes in the tropics Rege (1998) showed that at the same level of indigenous genes inheritance, crosses of different exotic breeds differed in their performance indicating that no one breed, crossbreed or crossbreeding strategy will have superior aggregate performance in all production environments. Farmer's knowledge and preferences about the genotypes should therefore be an integral part of breed improvement efforts because farmers adopt and adapt genotypes to their needs and circumstances (Bebe *et al*, 2000). For example, farmers might tend to upgrade to higher exotic grades and/or Friesian based on cross breeding for higher milk yields even though the overall productivity, on the account of reproduction and production, may be low. In addition, large dairy breeds are associated with high milk yields and are likely to be more popular than smaller breeds in production systems such as found in Kenya where milk is sold on volume basis (Bebe, 2003).

The breeding practice, importance of farmers' breeding objectives, preferences for different traits, criteria used for selection of dairy breed and mating system as breed improvement strategy under low-input systems have not been documented for smallholder dairying in Tigray region, particularly central zone of Tigray, which necessitates undertaking this study.

Reproductive performance of the cow and heifer is one of the most important factors that influence dairy sector profitability. Reproductive performance has been declining in dairy cows with increasing number of days open and decreased conception rates over the last 25 years (Silvia, 1998). One major problem is lack of accurate estrus detection. Most cow operations would benefit economically by reducing the number of operational days, decreasing culling rates due to non-pregnant females, and shortening their calving interval thorough reproductive management (Graves, 2009).

Synchronization of estrus (heat) is a reproductive management tool which involves manipulating the estrous cycle of females, so that they can be bred at approximately the same time (Rick and Gene, 2013). Estrus synchronization programs improve reproduction efficiency by reducing the length of breeding and calving seasons and increasing calf weaning weights (Gupta *et al*., 2008). The reproductive performance of a dairy herd has a significant effect on the profitability of that herd. Common measures of reproductive performance are days to first service, days to conception, calving interval, services per conception, conception rate, estrus detection rate, and pregnancy rate. Pregnancy rate is an overall measure of reproductive performance (AlbertdeVries *et al.,* 2012).

For a dairy cow to produce more offspring during her life in a herd she should calve first at two years of age and again every 12 months until she is culled (Etherington *et al.,* 1984). This pattern will also optimize the milk production in her life time. Unfortunately this seldom occurs because the interval from calving to subsequent conception is prolonged. Increased calving to conception intervals is affected by inadequate nutrition, uterine infection, poor estrus detection, or a decision on the part of managerial activities (Etherington *et al.,* 1984). In this regard, one of the most effective ways to improve both the reproductive performance as well as genetic performance is utilizing of superior sires through artificial insemination combined with estrous synchronization (Million *et al.,* 2011). The primary goal of any estrous synchronization protocol is to induce a compact estrous response so that cattle can be inseminated at a predetermined time period with acceptable fertility (Noseir, 2003).

Fertility is an important factor for the production and profitability in dairy herds (Gokhan, 2010). A calving interval of 12 to 13 months is generally considered to be economically optimal, but often difficult to achieve. To meet this goal cows must cycle and become pregnant within an average of 85 days postpartum. Estrus (heat) detection has been cited as the most important factor affecting the reproductive success of artificial insemination programs (Aulakh, 2008). However, proper control of the time of estrus is difficult, since peak estrus activity often occurs at night, and determination of the actual onset of standing estrus may be difficult without 24 hour observation (Aulakh, 2008).

Estrus synchronization as reproductive management tool was started in 2011 in Tigray Regional State, Ethiopia in small scale areas by agricultural research institution. More than 198 cows were synchronized in the first phase and 60% of them were positive in pregnancy (Azage, *et al.,* 2013). Tigray bureau of agriculture in collaboration with Tigray agricultural research institute scaled up the synchronization technology in 19 district of Tigray. From 2011-2013, 31,864 cows were synchronized in mass in Tigray region. From these cows 11,373 (35.69%) of cows were from central zone of Tigray (BoARD, 2013). However, there was no comprehensive assessment and evaluation of synchronized dairy cattle reproductive performance attributed to synchronization intervention for future planning.

Prostaglandin and progesterone is used to synchronize estrus in dairy cattle operations to boost the efficiency of AI by inducing the regression of the corpusluteum (Murugavel *et al*., 2010). The technology was used to synchronize estrus of dairy cattle in Tigray region. Prostaglandin is the first method of heat synchronization that depends on the presence of a functional Corpus luteum particularly in the diestrus stage of the estrous cycle (day 7 to 17 of the cycle) (Cordova-Izquierdo *et al*., 2009). PGF2α is not effective on newly established CL, and cows injected on days 1–5 of the estrous cycle are nonresponsive. There are a number of waves of follicular development in each estrous cycle, and cows injected on days 7 or 15 of the estrous cycle have a highly developed follicle ready to ovulate after CL regression. A practical approach to overcome this problem is injection of PGF2α twice, 11-14 days apart, so that the cows will be responsive to PGF2α at least at the second injection and come into estrus shortly thereafter (James, 2003).

Progesterone is a hormone produced and released into the blood by the corpus luteum on the ovary.The level of progesterone in milk can be used to evaluate estrus, embryo mortality and early pregnancy in dairy cattle. Early pregnancy diagnosis can improve reproductive performance by decreasing the interval between successive AI services and coupling a non pregnancy diagnosis with an aggressive strategy to rapidly rebreed these animals (Fricke, 2002).

Embryonic death is an important problem in stock breeding. Veterinary specialists and farmers find it difficult to solve this problem. Conception, gestation and giving birth to live fetus is a very complex process involving the embryo, the uterus, the mother's organism and the environment. The factors determining the normal embryonic development are numerous. Those are managing the genetic factors, the insemination, stress and animal health (Farin et al., 2001).

The percentage of insemination in cattle is about 90-100%, and only 70% of all pregnancies end with giving birth to live fetuses. The other 30% of pregnancies are interrupted because of some type of embryonic loss; in 65% of these cases, the embryonic death occurred between the 6th and 18th days of gestation (Dimitrov *et al.*, 2002). Embryonic death can be also as great as 20 percent to 40 percent during the first 30 to 40 days of pregnancy (Purohit, 2010).
This level of loss should not be allowed in stock breeding. Therefore our knowledge of embryonic death incidence would be of immense benefits in any efforts at improving live stock productions. The purpose of the study was to establish the diffusion of embryonic death among milk cows using hormonost micro lab farmer test, research to value pregnancy in early period of gestation and to improve production in stock breeding farms by reducing the interval between inseminations and service period.

Therefore to boost the dairy industries and to alleviate the problems of the above mentioned gaps, the study was designed for assessing of breeding practice and evaluates the success of estrus synchronization of dairy cattle under small holders' condition.

General objective

To asses breeding practices and evaluate estrus synchronization of dairy cattle in central zone of Tigray.

Specific objectives

To asses breeding practice of dairy cattle in central zone of Tigray
To evaluate mass synchronization efficiency of dairy cattle in central zone of Tigray
To evaluate single and double shots of prostaglandin hormone in dairy cattle
To analyze progesterone profile for determining pregnancy and embryonic mortality of lactating dairy cattle

2. LITERATURE REVIEW

2.1. Breeding Practices

A precise definition of the breeding objective is the first and probably most important step to be taken. Without it, the programme could result in genetic change, but in the wrong direction. Improving the wrong traits is equivalent or even worse than no improvement at all (Vanderwerf, 2004 ;). The breeding objective in any livestock species is to increase profit by improving production efficiency (Charfeddine, 2000).

In most of the countries in the tropics, both AI and natural service are practiced as methods of breeding. Access to AI services within a country depends heavily on geographical location, being more widely available near cities or ‘milk pockets’ and being less available in areas with low farm density. When selection of a stud bull is possible, it’s mostly by phenotypic selection on the performance of the bull. When pedigree is accounted for, the bull’s dam is given more consideration than the sire. However, from the point of view of the farmer, the convenience in the availability of the bull or AI service is usually more important than the genetic makeup of the animal. This is a logical decision, especially in the short term, as increased calving intervals are associated with decreased income through longer dry periods and fewer calves over a lifetime (Bebe, 2003). The replacement females for the cattle herd are usually from the heifers bred within the same herd regardless of the size of the farm, but this rule is especially true for small holders.

Larger herds will have a higher percentage of replacement heifers purchased from ‘outside’ sources, but also sell more females. The reason for this is tied directly to size. First, larger herds are often in phases of expansion, and thus need more females than could have been produced by the existing herd of cows. Second, the larger farms are usually more market oriented and will have more available cash flow. Finally, large farms may choose to specialize and direct their attention to milking adult cows and may thus sell off young female calves to be raised by others.

In addition, pedigree and performance recording systems are essentially non-existent, so there is usually nothing concrete beyond phenotypic appearance upon which to base the payment of a premium for a higher quality animal. Breeding structures provide systems for gathering information about assessment of animals in the production system and conditions that allow selection of parents (males and females) of future progeny, and the mating of these animals in a desired manner (vanderwerf, 2007). A breeding programme must consider and address how superior animals will disseminate their genes quickly throughout the whole population.

When answering this question, production systems, farmers' constraints and available infrastructure must be considered seriously if the breeding programme is to be sustainable. Climatic factors also introduce difficulties in the survival and productivity of the improved animals. Heat can be excessive and severely decrease fertility. Parasites and other diseases also contribute to reduce productivity and longevity. Losses due to high mortality of animals, particularly in calves, also constrain genetic gain in the population by decreasing selection intensity.

In addition, the best young males (dairy) are often sold for beef due to lack of means to identify best animals. Farmers often have a relatively low level of formal education and may have variable knowledge of husbandry to help overcome the problems in managing improved genetic material, as their indigenous knowledge was most applicable to the raising of local breeds. Finally, when farms are far from these urban centers, formal market access, poor transportation, and communication difficulties in many parts of the countries contribute to unprofitable dairying by decreasing the motivation to increase productivity (Buvanendran, 1980).

2.1.1. Reproductive efficiency

Reproductive performance is a trait of outstanding importance in dairy cattle enterprises. The size of the calf crop is all-important for herd replacement and the production of milk depends heavily on reproductive activity. Possible genetic improvement in virtually all traits of economic importance is closely tied to reproductive rate.

The improvement of livestock production in developed countries is due to the integrated effect of rapid development in several fields of the sector. Increased feed production, improved animal health, better husbandry, and the breeding of animals with the necessary genetic potential for improved performance are the most important of this development. In developing countries, however, parallel improvements in livestock production have generally been inadequate, and one of the limiting factors has been the lack of genetically improved animals. The importation of superior breeding stock is too costly to be adopted on a large scale. Problems of adaptability also arise when high-yielding cattle are transferred from temperate tropical and sub tropical environments. Crossing local females with superior improved sires is another method adopted at different period by many developing countries. With the advent of artificial insemination, the product of cross breeding was given a new technique for implementation on large scale and at comparatively low cost.

2.1. 1.1. Number of inseminations per conception (NSC)

The average number of services per conception at the Asella livestock farm was recorded higher and it was a clear indication of inefficiency in the artificial insemination operations (Enyew, 1992). The major causes of inefficient artificial insemination service results were due to absence of proper heat detection, timely insemination, efficient artificial insemination technician, effective and timely pregnancy diagnosis and regular follow up of reproductive problems in the cows combined with other herd management practices.

Rao (1996) reported on indigenous cows and crossbreds formed by mating of indigenous cows with Jersey or Holstein sires were inseminated with semen form Jersey, Holstein or

Jersey crossbred bulls and significantly higher proportions of Jersey crossbred and indigenous cows were inseminated in summer and spring respectively than in other season. For Jersey crossbred cows, conception rate to first insemination was higher in winter than in summer ($P < 0.01$), but there was no effect of season on estrus activity.

Reproductive performance of Zebu, Friesian and their crosses reported that the number of services required per conception tends to decrease with increasing Friesian inheritance among dam breeds. Hence, the highest number of service per conception was required for Fogera cows and the lowest percent for Friesian cows (Mekonnen and Goshu, 1987). However, the opposite was true for sire breeds. Cows sired by local bulls required fewer services while with increasing level of Friesian inheritance, the number tends to increase. This might indicate that Friesian bulls and their crosses probably produced relatively poor semen quality, which might have been attributed to high ambient temperature of Gondar Station.

A significant effect of year on the number of services per conception (NSC) was reported by (Mekonnen and Goshu, 1987). This may be due to the fact that artificial inseminators were provided with bonus for each successful insemination they achieved and in later years this incentive was ceased and again reinitiated. Thus, a clear picture was depicted which showed provision of bonus resulted in less service per conception. Heifers conceiving in the main wet season (July to October) required fewer NSC than those conceiving during the other seasons. The observed reduction in NSC for those conceived during the dry season compared to wet season, may be related to occurrence of high temperatures and feed scarcity during dry season.

Parity exerted a significant effect on the number of service required per conception and on both days open and calving interval. The result obtained at Assella livestock farm in Arsi, by Enyew *et al*. (1999) indicated a clear trend of improvement of NSC after the first parity and continued up to the fourth parity. The NSC decreased from 2.1 in the first parity to 1.6 in the fourth parity. The cause of this age related difference in reproductive performance might be due to delayed resumption of ovarian activity after calving during first parity cows.

A similar trend was observed for the NSC during later years. In the same study high annual variability was recorded. The possible reasons for the observed annual variability and marked increase in the NSC during the same years could be a lack of deep frozen semen during some period of the project, annual climatic change in relation to feed availability and different management parameters.

2.1.1.2. Age at first calving (AFC)

It is the period between birth and first calving and influences both the productive and reproductive life of the female, directly through its effect on her lifetime calf crop and milk production and indirectly through its influence on the cost invested for up-bringing (Perera, 1996).

The overall mean for AFS and AFC on reproductive performance of crossbred dairy cows under small scale dairy conditions in urban and per-urban areas of Gondar was 15.4 months (n=384) and 32.4 months (n=384) (Nibret, 2012*)*.

The mean age at first calving was found to be 3.05±0.65 years (Belay, *et al*, 2012) in Jimma town. A substantial delay in the attainment of sexual maturity may mean a serious economic loss, due to an additional, non- lactating, unproductive period of the cow over several months (Mukasa-Mugerwa, 1989).

2.1.1.3. Days open (DO) and calving interval (CI)

Calving interval is the period between consecutive calving and is a function of days open (period from calving to next conception) and gestation length. Since gestation length is more or less constant for a given breed, the number of days open to conception becomes the sole variable of calving interval. The reasonably short calving intervals of 12-13 months indicate an optimum combination of good management and sound physiological condition of the cow.

Days open till conception is defined as the interval from calving to the day of conception, which includes the postpartum anoestrous interval and service period. Days open is the most variable determining component of calving interval and is mostly influenced by the length of time for the uterus to completely involutes, resumption of normal ovarian cyclist, occurrence of silent ovulations, accuracy of heat detection, management decisions on how soon to rebreed following parturition, fertility of a bull or semen and efficiency and/or skill of inseminator.

Mayne *et al*. (2002) reported that herds with high heat detection rates had significantly shorter calving intervals and significantly lower 305-day protein yields, less body condition loss after calving, and significantly smaller negative energy balances. They concluded that calving interval shorter than 380 days is achievable by minimizing negative energy balance in early lactation, good heat detection, and early insemination of cows after calving.

The average days open till conception of dairy cattle was 155.7±1.72 days. Feed shortage, silent estrus and lack of proper heat detection might have contributed considerably to the long days open reported in their study (Belay *et al.*, 2012*).*

In the Republic of Malawi working on government farm and smallholder reproductive performance was obtained 510 ± 168 days and 231 ± 170 days of calving interval and days open, respectively. The long calving interval of almost 16.7 months observed in their study was attributable to the long period of day open period of almost 7.5 months. This long period of days open till conception was said to be possible result of phosphorus deficiency in the animal diet, the smallholders' reluctance to allow artificial insemination of their cows, failure of farmers to detect heat and inefficiency in the artificial insemination service (Kwaku and Nkhonjera, 1986).

First crosses in general and Jersey in particular, had the best reproductive efficiency with lower AFC, NSC, shorter DO and CI than the high grades. The heterotic effect of crossbreeding on reproductive performance has been reported by (Zegeye, 1976). Thus in case of Holstein X Ayshire cows found to have 4.7 days less DO period than pure Holstein cows. Azage (1981) reported 215.7, 250.7 ± 16.8 and 188.8 ± 21.1 DO for highland and lowland local cows and for highland crossbred cows, respectively.

Parity exerted a significant effect on the number of services required per conception and on both DO and CI. Enyew *et al.* (1999) indicated a clear trend of improvement after the first parity and continued up to the fourth parity. Thus, DO decrease from 263.3 to 166.4 days and CI decreased from 528.3 to 427.9 days.

2.2. Physiology of Estrus Cycle

The estrous cycle of the cow is generally about 21 days long, but it can range from 17 to 24 days in duration. Each cycle consists of a long luteal phase (days 1-17) where the cycle is under the influence of progesterone and a shorter follicular phase (days 18-21) where the cycle is under the influence of estrogen. The cycle begins with standing heat, or estrus. This time of peak estrogen secretion can last from 6 to 24 hours, with ovulation occurring 24 to 32 hours after the beginning of estrus (Williams *et al.*, 2002). Ovulation marks the beginning of the luteal phase, and is the culmination of a process called oogenesis, in which germ cells mature under the proper conditions. Germ cells are contained in thousands of tiny structures called follicles that contain receptors for FSH, which in turn stimulates the growth and maturation of responsive follicles. Most follicles develop in patterns referred to as follicular waves (Rick, 1999).

Ovarian follicular growth in cows occurs in waves. A wave of follicular growth involves the synchronous development of a group of follicles, one of which become dominant and achieves the greatest diameter suppressing the growth of the subordinate smaller follicles (Pierson and Ginther, 1987).

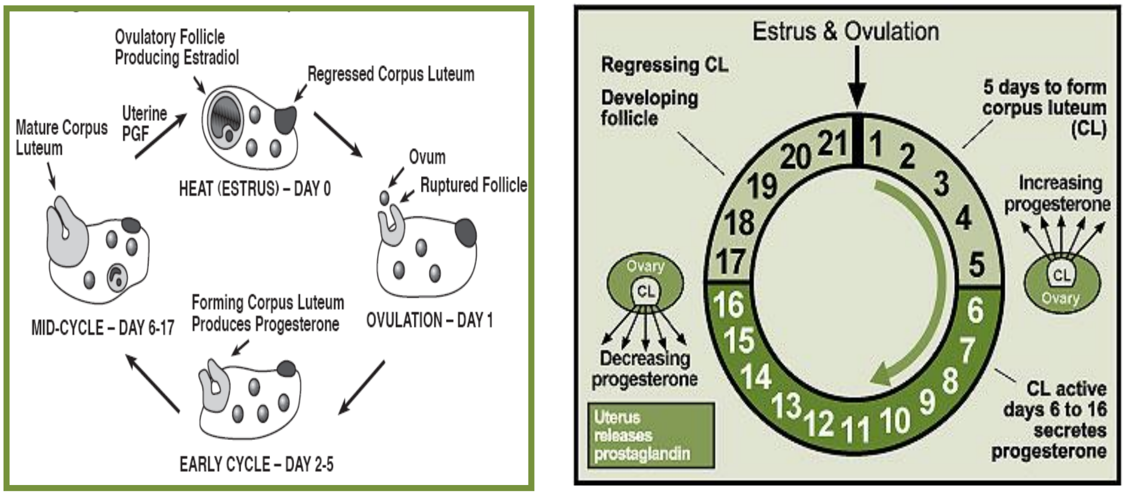

Figure 1. Formation of Corpus Luteum (left) and Physiology of the estrous cycle (right)

2.3. Endocrinology of Estrous Cycle

Estrous cycles give females repeated opportunities to become pregnant throughout their productive lifetime. The cycle is regulated by the hypothalamic-pituitary-gonadal axis, which produces hormones that dictate reproductive events. The reproductive axis is composed of the hypothalamus, pituitary, and the ovary (Rick, 1999).

The hypothalamus is a specialized portion of the central brain. Its primary function is to produce gonadotropin-releasing hormone (GnRH) in response to circulating estrogen, or to cease GnRH production in response to progesterone. The anterior pituitary is located directly beneath the hypothalamus in a small depression of the sphenoid bone. It produces the gonadotropin follicle-stimulating hormone (FSH) and luteinizing hormone (LH) in response to GnRH and estrogen. FSH and LH production is inhibited by progesterone. The third portion of the reproductive axis consists of the ovaries, located in the pelvic cavity of the cow. Follicles are structures on the ovarian surface that contain ova (egg) and produce estrogen. Follicles range in size and maturity at different stages of the cycle, but usually only one is selected to ovulate. A corpus luteum (CL) is a structure that forms from the previous cycle’s ovulation point. The Corpus luteum is responsible for progesterone production. Both estrogen and progesterone are produced following FSH and LH stimulation of the ovary. The uterus is also found in the pelvic cavity. It likewise contributes to reproductive control, as it produces prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) (Williams *et al.*, 2002).

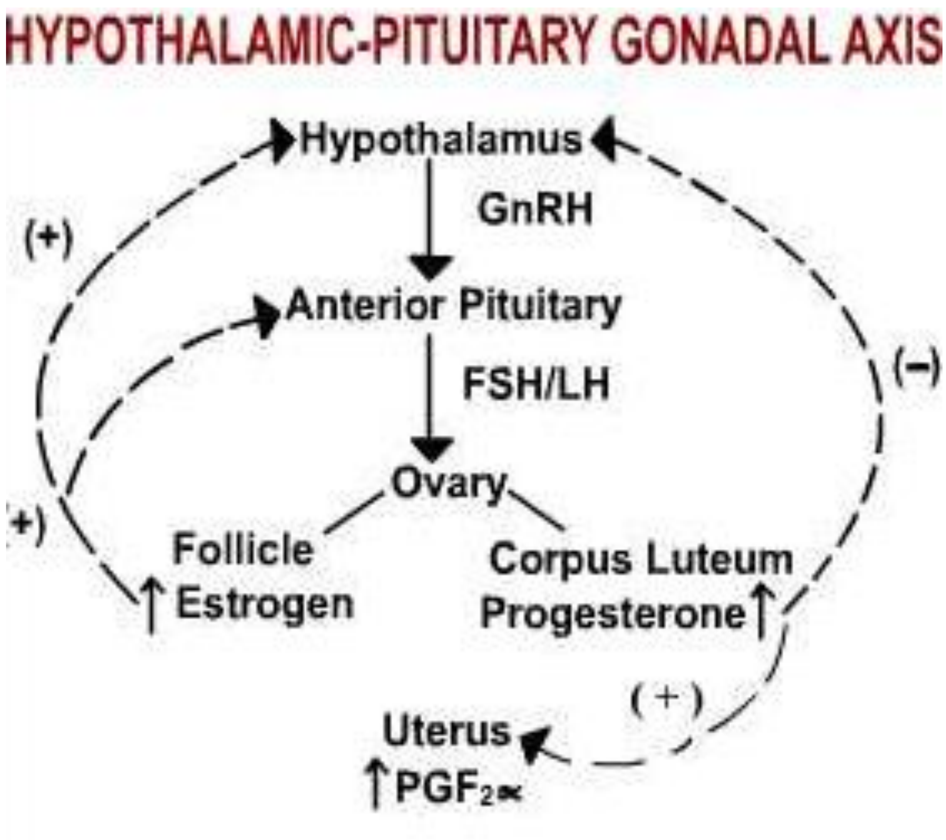

Figure 2. The reproductive axis - hypothalamus, pituitary, and the ovary

2.4. Estrus Synchronization

Synchronization of the estrous cycle has the potential to shorten the calving season, increase calf uniformity, and enhance the possibilities for utilizing AI (Lamb, 2010). Synchronization of estrus contributes to optimizing the use of time, labor, and financial resources by shortening the calving season, in addition to increasing the uniformity of the calf crop. The major limitation of estrus-synchronization programs is their inability to induce a potentially fertile estrus and ovulation in non-cycling cattle (i.e., pre-pubertal heifers and anestrous suckling cattle). Because initial estrus-synchronization programs were not designed for successful treatment of non-cycling cattle, their use in cow-calf operations generally has not produced results that would encourage greater A.I use for cattle.

The major factor limiting optimum reproductive performance on many farms is failure to detect estrus in a timely and accurate manner (Graves, 2009). Cows come into estrus at all times of the day and remain in heat for only 12-18 hours making it difficult to observe estrus especially in hot weather. Keeping cows in groups of three to five with two to three visual observations per day for heat will increase the chances of detecting cycling animals. The use of synchronization and heat-detection aids can greatly shorten the time spent observing heat but will not benefit non-cycling cows or Anestrous Cows - a condition where the cow does not cycle due to insufficient natural hormonal stimuli (Pennington, 2013). Conception rate to first service was significantly higher in Insemination at detected estrus than in Ovarian Synchronization (45.1 vs. 34.5%) (Tenhagen *et al.,* 2004).

In the existing AI One AI technician is expected to inseminate on average about 300 cows per year, and in practice ranges from 50 to 1000. Pregnancy rate to 1st insemination is 27% in the existing AI system Desalegn *et al*. (2008), where as using estrus synchronization Results showed that number of animals responded to Prostaglandin are 100% and pregnancy rate after first insemination can be improved from 27 % to about 60% mainly as a result of timely availability of well-trained AI technicians at the time of planned heat period (Azage *et al*, 2013).

2.4.1. Purposes of estrus synchronization

Realistic economic benefits of improved reproductive performance are not simple to estimate. When reproductive performance improves, all changes in cash flows that result from the improvement must be accounted for. So for a good analysis, we need at least realistic estimates of lactation curves, feed intake, the risk of involuntary culling, and prices such as for milk, feed, labor, semen, fertility drugs, calves, replacement heifers and cull cows (Albert de Vries *et al.,* 2012).

The objective of a synchronization program is to breed a high percentage of the females in a given group of heifers or cows in a short period of time, using either artificial insemination (A.I.) or natural service (bulls) (Noseir, 2003). Through effective implementation we accomplish the following: Concentration of the breeding season, Concentration of the calving season (focuses the workload), More uniform calf crop, typically improves returns (increases value of calf crop) and Facilitates the use of A. I. by concentrating estrus detection requirements (Stephen, 2000).

2.4.2. Principles of synchronization

Synchronization of estrus in cows is feasible by either curtailing or extending the length of estrus cycle, which can be maintained based on two principles; one is using of in-situ luteolytic agent (prostaglandin) that induces luteolysis of corpus luteum (CL) and exogenous administration of such agents mimics premature luteolysis and hence results in to shortening of left over diestrus phase of estrus cycle; and the second principles is lengthening of diestrus phase through maintenance of Corpus luteum in terms of progesterone production which determines the length of diestrus phase. Hence, with the administration of progesterone hormone, the diestrus phase can be extended.

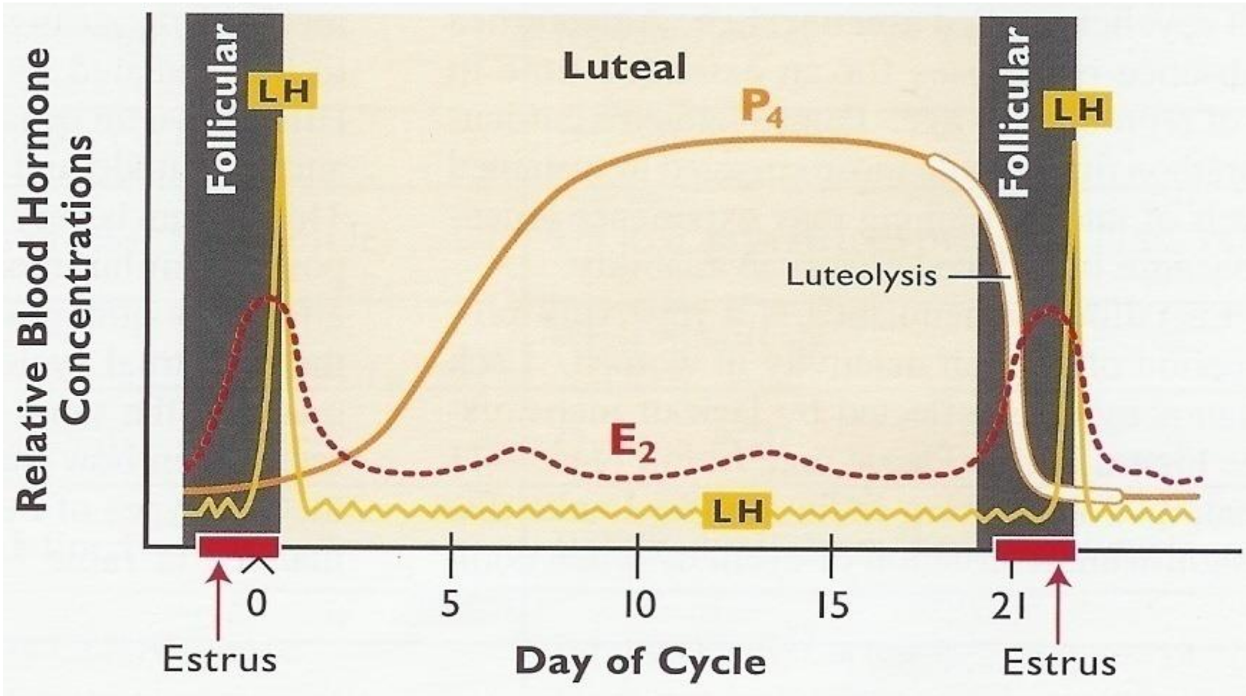

Figure 3. Principles of synchronization (Hormonal concentration and estrus cycle)

2.4.3. Factors affecting estrus synchronization

High priority needs to be placed on transferring these current reproductive management tools and technology to producers, veterinarians and industry personnel to ensure they are adopted at the producer level and to provide the necessary technical support to achieve optimum results. Because current management, breed, economic, location, and marketing options are producer specific, it is essential to ensure that transfer of this technology is not presented in blanket recommendations (Lamb, 2010).

For a synchronization program to work the way it should, several issues must be considered, some of them are listed below.

Cattle must be in good body condition or on a gaining plane of nutrition. This involves adequate levels of dry matter in general but specifically protein, energy minerals and vitamins. Cattle must be cycling, prevention and treatment of diseases, control of parasites is important. Time and labor available for product administration, heat detection and breeding especially with A.I, if natural service is to be used bull to cow ratio has to be considered. Recent studies suggest that one bull can service 25 synchronized females. The bull(s) need to be 2 years or older, experienced and in good condition (Stephen, 2000).

2.5. Prostaglandin

Prostaglandin (PGF2α) is a naturally occurring hormone. During the normal estrous cycle of a non-pregnant animal, PGF2α is released from the uterus 16 to 18 days after the animal was in heat. This release of PGF2α functions to destroy the corpus luteum (CL). The Corpus luteum is a structure in the ovary that produces the hormone progesterone and prevents the animal from returning to estrus. The release of PGF2α from the uterus is the triggering mechanism that results in the animal returning to estrus every 21 days. Several prostaglandin (PG) products are available for use in synchronizing estrus in heifers and lactating dairy cattle. These products were originally used to treat individual cows that had not exhibited heat by the time of desired first service. Commercially available PGF2α (Lutalyse, Estrumate, and Prostamate) gives the herd owner the ability to simultaneously remove the Corpus luteum from all cycling animals at a predetermined time that is convenient for heat detection and breeding (Dejarnette, 2004).

These days, prostaglandin is used to synchronize estrus in dairy cattle operations to boost the efficiency of AI by inducing the regression of the corpusluteum (Murugavel *et al.*, 2010). Prostaglandin is the first method of heat synchronization that depends on the presence of a functional Corpusluteum particularly in the diestrus stage of the estrous cycle (day 7 to 17 of the cycle). Its effectiveness usually affected by heat stress, asynchronous ovarian events exhibiting incomplete or delayed luteolysis, and weak or delayed estrous (Dejarnette, 2004; Mgongo *et al*., 2008 and Lamb, 2010). Recently, a new program, Ovsynch, using gonadotropin-releasing hormone (GnRH) with Prostaglandin has been introduced (O'Connor, 2003). Prostaglandin products have the trade names of Lutalyse, Estrumate, and In-Synch and each contain prostaglandin F2 α (PGF2α) or an analogue of PGF2α (Graves, 2012).

Several researchers have noted normal or above normal fertility following synchronization of estrus with PGF2α in cows (Stephen, 2000). Young (1981) found no significant difference in conception rates among cows inseminated at the fixed time of 75 to 80 hours (46%), after a double 11 day interval treatment regimen using a prostaglandin analogue, cows inseminated twice at 72 and at 96 hours (47%) after the same treatment and control untreated cows (50%). However, improved conception rates have been noted after AI at detected estrus compared with timed AI after prostaglandin administration, due to variations in the time of ovulation (Heuwieser, 1997). Reproductive performance in dairy cattle was also improved following double 14-day PGF2α treatment without assessing ovarian status when compared with a single dose based on detecting a corpus luteum by rectal palpation or by milk progesterone enzyme immunoassay. Tenhagen *et al* (2000) noted that timed insemination after double 14-day prostaglandin treatment reduced the number of days open in lactating dairy cows when compared with AI performed at observed estrus.

There is considerable evidence that PGF2α is capable of improving the reproductive performance of dairy cows when given before the end of the voluntary waiting period (parsley, 1995). Administering PGF2α during the early postpartum period led to increased first service conception rates related to the associated benefits of enhancing uterine activity, thereby decreasing the interval between calving and conception. However, others suggest that the diminished intercalving period may be an effect of luteolysis and an increased number of estrus cycles. In a meta-analysis, Burton and Lean explored the effects of prostaglandin given in the early postpartum on the subsequent reproductive performance of dairy cattle. Meta-analysis of the effect of prostaglandin treatment during the early postpartum period revealed no increase in pregnancy rate to first artificial insemination in cows with a normal or abnormal puerperium, while the period from calving to first AI was significantly reduced, thus reducing the number of days open in the dairy farm (Imwalle,1998).

The major limitation of PGF2α is that it is not effective on animals that do not possess a Corpus luteum. This includes animals within 6 to 7 days of a previous heat, prepubertal heifers and postpartum anestrous cows. Despite these limitations, prostaglandins are the simplest method to synchronize estrus in cattle.

2.5.1. Two-shot PGF2α protocol

The most common method of synchronization with PGF2α is to inject all animals and breed those that come into heat over the next 5 to 7 days. Animals not detected in estrus after the first injection are re injected 14 days later and bred over the next 5 to 7 day period. Animals detected in standing heat should be inseminated 8-12 hours later. If labor availability is a limitation, all heat detection and breeding can be delayed until after the second PGF2α injection. This allows the producer to breed a high percentage of the herd during a single 5-7 day period, but requires two doses of PGF2α/head. Overall estrus response rates may be slightly reduced (~5%) when animals are bred only after the second injection as some animals that responded to the first injection may not respond again to the second. Although historic recommendations were to inject PGF2α at 11-day intervals, from a scheduling consideration, the 14-day interval is much easier to implement. These “early” Corpus luteum typically do not respond to PGF2α as well as older more mature ones. Using a 14-day interval, a missed heat from the first injection will be on days 10 to 12 of the cycle at the second injection (DeJarnette, 2004).

The successful use of a new estrus synchronization protocol for lactating dairy cows has been described, in which three PGF2α doses are given (Nebel and Jobst, 1998). In this protocol, known as the Targeted Breeding Program, all the animals that were not detected to be at estrus following the first PGF2α injection were treated with a further two doses of PGF2a at 14-day intervals until artificial insemination at detected estrus or until timed artificial insemination was performed 72 to 80 hours after the third PGF2α dose.

2.6. Assessing and Characterizing the Progesterone Profile

Progesterone is a hormone produced and released into the blood by the corpus luteum on the ovary. The corpus luteum is formed after the follicle has ovulated. This hormone is low during heat, and begins to rise after ovulation as the corpus luteum develops. If the cow was bred and becomes pregnant, progesterone in blood and milk remains high until just prior to calving. If the cow does not conceive, the corpus luteum begins to degenerate on approximately day 17 of the cycle, and progesterone declines to minimal concentrations on days 20 through 23 as the cow returns to heat (O'Connor, 2003).

The concentration of progesterone in the blood is correlated closely with the concentration in milk. In fact, since progesterone is a steroid hormone, it has an affinity for milk fat; thus progesterone in milk is somewhat higher than in blood. Variation in the concentration of progesterone in milk due to stage of the cycle or pregnancy status is much greater than the effect caused by the variation in fat content (IAEA, 2007). The cows were being bred when progesterone concentrations were high. Thus these cows were not in or near heat when inseminated. Progesterone testing can be an accurate method of evaluating heat detection on an individual basis. To make the evaluation worthwhile, 15 to 20 cows should be sampled on the day of insemination. Milk samples should be obtained at the milking immediately after insemination. If milk samples are collected frequently at specified intervals, this tool can be used to detect anestrous cows, early embryonic death and monitor response of treatment with various treatments such as prostaglandins. It may also be helpful in differentiating between follicular and luteal cysts. Since prostaglandins are being used more frequently in synchronization programs for lactating cattle and the effectiveness of this treatment depends on presence of a functional corpus luteum on the ovary. Progesterone analysis can be useful in verifying if a corpus luteum is present (Perez-Marin & Espana, 2007).

Conception rates are approximately 35% or lower for timed insemination (Pancarci et al., 2002). Loss of pregnancy after early diagnosis is a factor in decreased reproductive efficiency. In recent studies, 7–33% of pregnancies in lactating dairy cows were lost between 28 and 98 days of gestation (Nation *et al*., 2003). Dailey *et al*. (2002) postulated that most loss of pregnancy occurs prior to day 45 of gestation.

After early embryonic mortality a sharp drop in progesterone and a gradual decline in pregnancy associated glycoprotein(PAG) concentrations were observed in a Borana cow that experienced spontaneous abortion after approximately 10 weeks of gestation (Fikre, 2007).

Embryonic death can be as great as 20 percent to 40 percent during the first 30 to 40 days of pregnancy. Testing an additional milk sample on days 40 to 50 after breeding will confirm maintenance of pregnancy past this critical period (Purohit, 2010).

Table 1.Progesterone analysis from pregnant cows

No.	Cow	Accuflrm	DiaSystems	Progesterone assay	RIA ng/ml	
					Milk	Plasma
	5046	P	P	P	5.6	10.8
	637	P	P	P	4.0	12.6
	1234	P	P	P	4.7	5.6
	1236	P	P	P	9.1	7.8
	1310	P	P	P	5.8	7.2

P= pregnant color
Source; Fisher *et al*- 2004

2.6.1. Hormonost micro lab farmers test

Quantitative rapid assay with the test device Fertility Box® Cow for determining the progesterone content of milk samples of dairy cows. It is a semi-automatic method and doesn't require any previous knowledge. In other words, you don't need to be an expert to use it. First, choose which language you would like, and then follow the instructions on the display to carry out the test. The Microlab device is clearly laid out and it is small – just like the cost (Dimensions: 18.5 cm × 9.5 cm × 4.5 cm).

Hormonost® Farmer test is a quantitative progesterone rapid assay for the control of fertility in dairy cows. The test is based on the first reliable progesterone rapid assay ‾Hormonost® dairy cow, in which the farmer can see the progesterone content by color differences using the naked eye. In the device Fertility Box®, the evaluation of colors is done objectively by a physico-technical method. This technique can detect even the slightest differences in color (and consequently in the progesterone level), which are invisible to the human eye. This is the background and the mythological pre-condition to fulfill the old great dream of finding the optimal day for artificial insemination (A.I.) when a cow is coming into a visible or silent heat at the end of a cycle (Daniel & Klaus,2014).

Hormonost®-Maicrolab can measure the estrous-valley within a cycle more accurately and precisely than any other progesterone test machine and therefore guide the herd manager more closely to the right A.I. day.

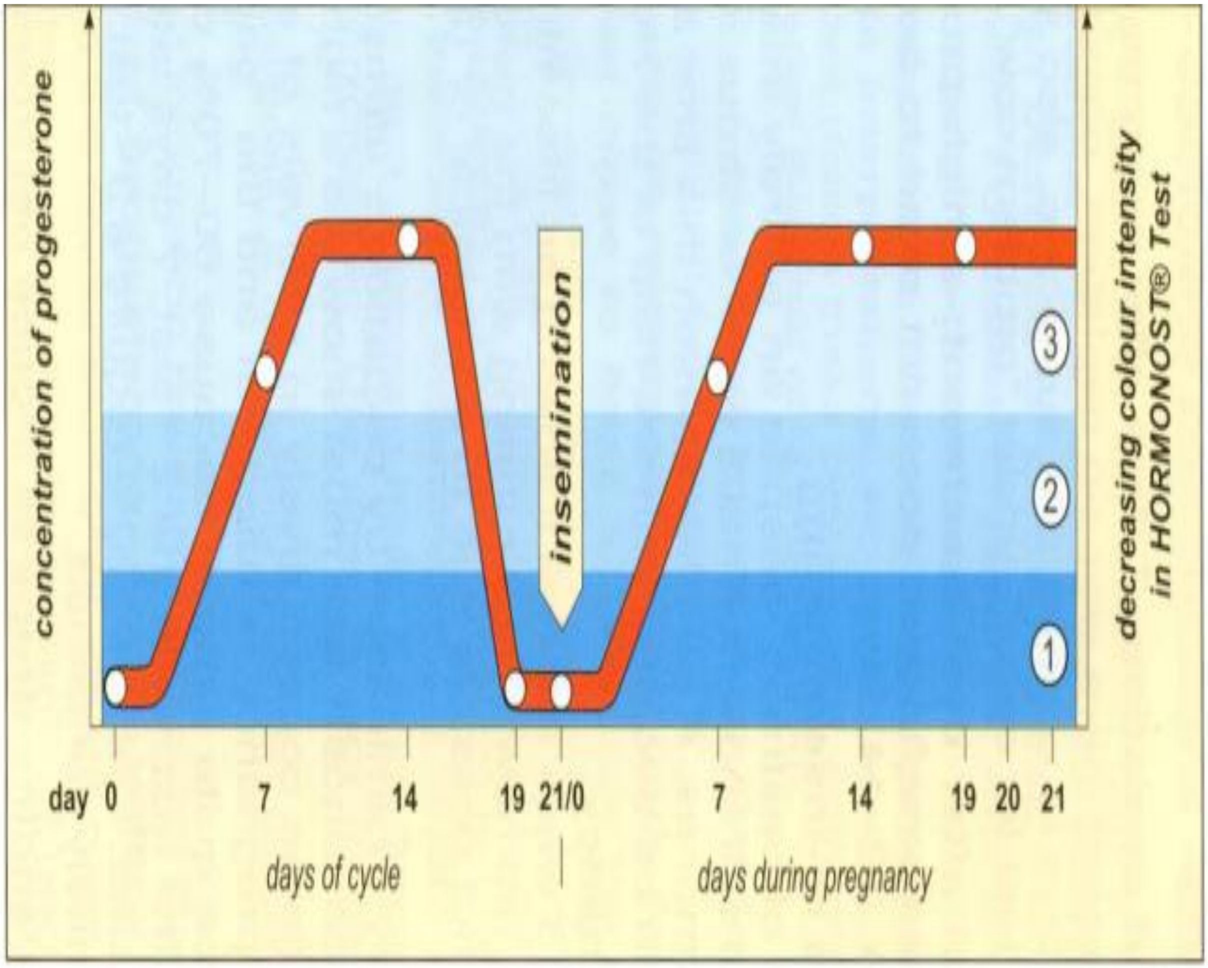

Figure 4. Progesterone profile and colors in test tube

3. MATERIALS AND METHODS

3.1. Description of Study Area

The study was carried out in three districts of central zone of Tigray region, Northern Ethiopia (Laelay Mychew, Adwa and Ahferom). The Central Tigray Zone is one of the five zones in Tigray National Regional State 1080 km far away from Addis Ababa. The zone approximately extends between $13^{o}15'$ and $14^{o}39'$ North latitude, and 38^{o} 34' and $39^{o}25'$ East longitude. The altitude of the zone mainly falls within the category of 1650 to 3000 masl. The larger part of the zone receives mean annual rainfall ranging from 400 to 800mm. The mean monthly maximum and minimum temperatures of the zone are 30^{o}C and 10^{o}C, respectively (NMSA, 1996). Central Tigray zone is bounded by Eritrea in the north, East Tigray zone in the East and south east, West Tigray zone in the west and Amhara National Regional State in the south. The zone with its capital in the ancient city of Aksum encompasses ten districts. The zone has the largest human population in the region. The farming system of the study area is largely characterized by mixed crop-livestock production system. The study area possesses lowland, midland and highland.

Laelay Mychew, Ahferom and Adwa possess a wide range of an altitude of 1400-2080 masl, 1805-2258 masl and 1514-3000 masl and received mean annual rainfall of 500-600mm, 600-850mm and 560-700mm respectively. The mean annual temperature is ranged in 15-25^{o}c, 18-28^{o}c and 18-27^{o}c for Laelay Mychew, Ahferom and Adwa respectively (Gebremedhin and Weldewahd, 2013).

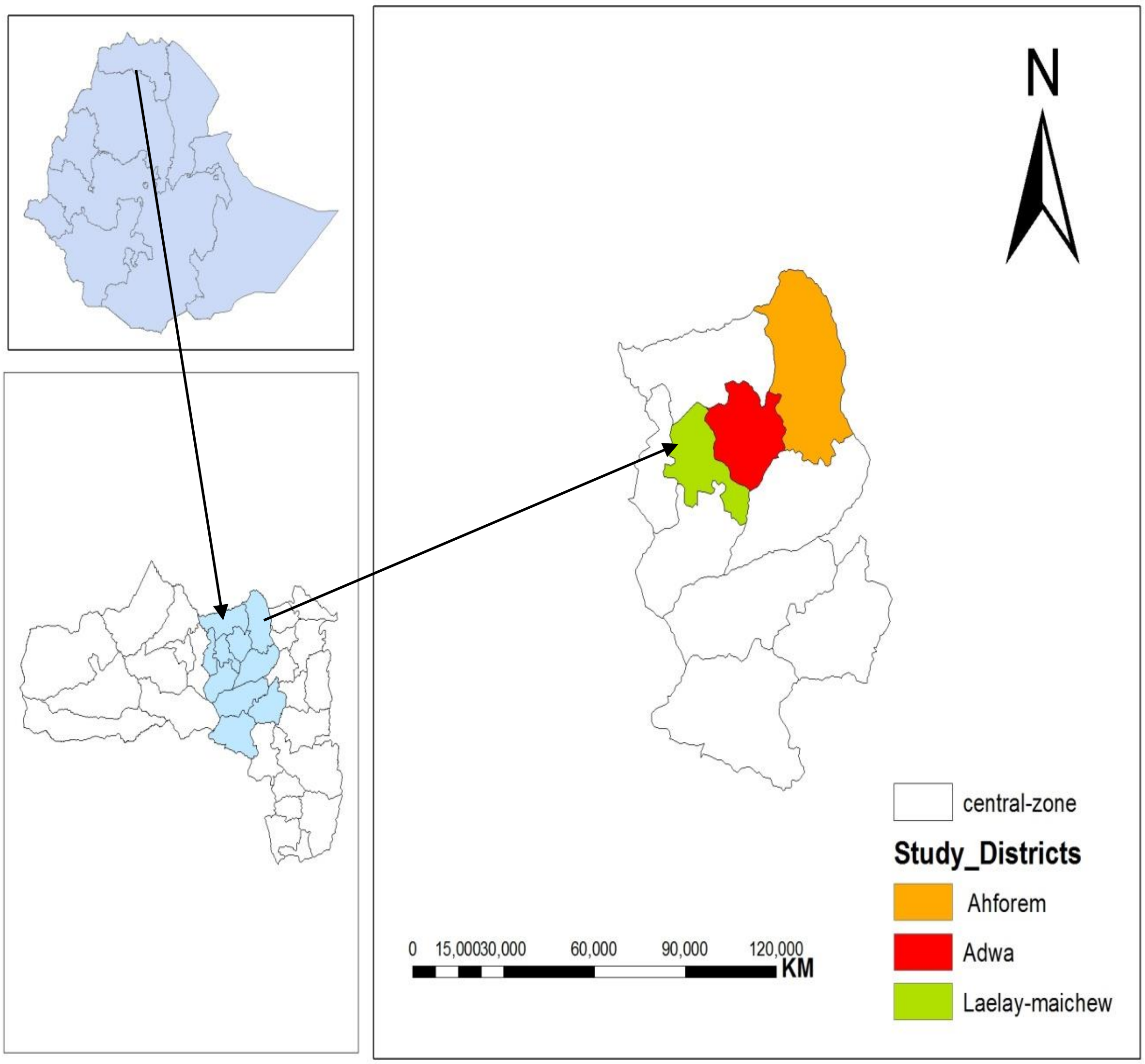

Figure 5. Map of the study areas

3.2. Sampling Methods and Data Collection

3.2.1 Assessment of breeding practices of dairy cattle

Based on their milking shed potentiality and dairy production availability, three districts from central zone and three kebeles from each district were purposively selected for questionnaire administration. Multistage sampling technique was used. First the kebeles in each district were classified as rural and per- urban. Then a total of 180 households (60 from each district) from which 113 households from rural areas and 67 from per-urban areas were randomly selected from the dairy holding households for the interview from the selected kebeles. Total sample size was used as follows (Cochran, 1963).

$$\text{Total sample (N)} = \frac{Z\alpha^2 \text{ x p (1-p)}}{d^2}$$

Where:

N=required sample size

P (expected proportion) = 0.135(if the population is homogenous)

d (desired absolute precision) = 0.05

$Z\alpha$ = 1.96(is the abscissa of a normal curve that cuts of an area at the tails (1-α equals to the desired confidence level, for 95%=1.96)

For the survey for required sample size of the respondent with 95% confidence level was calculated as, $N=Z\alpha^2 \times p\ (1-p)/d^2=[(1.96)^2 \times 0.135(1-0.135)]/(0.05 \times 0.05)$

$3.8416 \times 0.1168/0.0025=180$ farmers

The number of households in rural and per urban were determined by proportionate sampling technique.

3.2.1.2. Questionnaire administration

Data was collected from primary sources. A semi- structured Questionnaire was prepared and pre-test before administration and some re-arrangement, reframing and correcting in accordance with respondent perception was done. A pertinent questionnaire to the respective respondents to selected smallholder households and Artificial insemination technician in the study area was administered. The questionnaire was filled by trained enumerators recruited for the purpose with close supervision by the researcher. During the interview process, every respondent included in the study was briefed about the objective of the study before starting presenting the actual questions.

The information collected included issues related to socio-economic characteristics of the farmers, breeding practice (mating system, selection criteria, trait preference, routine husbandry practices etc), factors like cattle breed possessed, service per conception, heat detection techniques, milk production, lactation length, reproductive performance, distances from the AI center and status of AI technician, feed situation, veterinary services etc were assessed from recall survey.

3.2.1.3. Focus group and key informants discussion

Focus group and key informants' discussion were also conducted to strengthen the data obtained from structured and semi-structured questionnaire. The group was formed with 10 people and composed of youngsters, women, village leaders and socially respected individuals who are known to have better knowledge on the present and past social and economic status of the area**.**

The focus group discussions were focused on the history of the breeding practices of dairy cows, utility pattern of the dairy cow and AI services, current status and major constraints of the AI practices and services, major reproductive problems of dairy cow after AI, production system, indigenous knowledge on management of breeding, husbandry practices and their perception about synchronization and conception rate of AI practiced on indigenous dairy cows and their cross breeds using a prepared check list.

3.2.2. Evaluation of mass synchronization efficiency of dairy cattle

The sources of information for this study were secondary data obtained from record of AI centers. The data from inseminated dairy cows was collected from 2012 and 2013 from AI log book. Data were obtained from 701synchronized and inseminated dairy cows. From the Secondary data the dependant variables like conception rate and number of service per conception was evaluated. The independent variables (fixed effects) included in the study were, AI technician efficiency, dam breed, body condition, parity, year and bull effect.

3.2.3. Evaluation of single shot and double shot of prostaglandin

A total of 126 dairy cattle were selected purposely based on feed availability of the owner, body condition, age, health status and absence of pregnancy during synchronization. For this experiment the hormone $PGF2_{\alpha}$ which is Lutalyse was used. Single shot of $PGF_{2\alpha}$ were given for those dairy cattle that can come into heat and double shot for cows which did not come in to heat for first injection.

The main data collected during the work were name of AI technician, dam breed (Local, Holstein cross and Begait), body condition in the level of 1-5 grading, parity (1-4), bull id, and prostaglandin shoot. Based on these independent variables conception rate and number of service per conception were evaluated.

3.2.3.1. Method of using prostaglandin

As per rectal examination, 5ml of PGF2α (Lutalyse) were administered intramuscularly to those cows possessing Corpus luteum and not pregnant cows. Treated cows expressed estrus symptom in 3-5 days. Single and double PGF2α injection was given 14 days apart, so that the cows were responsive to PGF2α at least at the second injection and come into estrus shortly thereafter. Those cows come into estrus in the first injection were inseminated and the remaining cows who did not show estrus were injected with PGF2α at 14 days after the first injection and then inseminated when estrus was detected.

3.2.4. Milk sample collection & progesterone profile analysis

Out of 126 PGF2α treated and inseminated a total of 20 conceived lactating dairy cows from the districts were taken for progesterone profile analysis. The lactating cows were selected from those farmers which kept their cows in well managed manner. Repeated progesterone profile were recorded from conceived milk of lactating cows in 18,21,24,27,30,33,36,39,42,45 ,48,and 51 days of post AI to determine pregnancy and embryonic mortality. Cows with greater than or equal to 16ng/ml with colorless progesterone profile were taken as pregnant and less than 16ng/ml and blue color as non pregnant using hormonost micro lab farmers test device (Daniel & Klaus, 2014). Two graduated controls were included in the kit which is taken from estrus and pregnant cows for comparison and validation of the test. These controls are measured during incorporation into the new method. By matching the given target value of the controls within the tolerance limit (printed on the label of the control) were performed correctly. Correct handling is a primary and necessary condition for correct measuring in real milk samples. Those conditions were fulfilled and checked with the help of controls.

For confirmation of pregnancy, pregnancy diagnosis (PD) through rectal palpation was carried out two months after AI and the diagnostic results were recorded. Using progesterone profile obtained from milk sample cows with low progesterone (<16ng/ml) after repeated measurement were taken as cows suffered from embryonic mortality. After early embryonic mortality a sharp drop in progesterone and a gradual decline in pregnancy associated glycoprotein (PAG) concentrations were observed (Fikre, 2007).

3.2.4.1. Procedure of progesterone profile analysis

One hundred µl of milk was added in to the progesterone antibody coated test tubes and pressed the Enter button. Then 6 drops of milk diluter was added to the tubes and Shake for 10 second to mix the liquids in test tubes until the beep sound was stopped then "Wait ... until next step" and the remaining waiting time (5 min) was displayed.

At the end of the waiting time 100 µl of enzyme was added to the tubes to facilitate chemical reaction. Then pressed Enter immediately and Shake for 10 sec. After the mixing time (3 min) waiting time were displayed. At the end of the waiting period the tubes were taken to wash basin, filled with cold tap water and washed six times to remove the mixed items. The tubes were shaking three times strongly in order to remove residual water. The lower halves of the tubes were dried from the outside with a soft paper towel, in order to avoid damage to the electronics caused by carrying humidity into the Fertility Box® and placed the tubes into the Microtherme. By pressed the Enter button, (15 sec.) waiting time were displayed.

After the waiting time twelve drops of substrate was added quickly and evenly only in the first tube and putted the tube immediately into the tube shaft. The position of the test tube was corrected in 9 second until the printed line exactly meets the line in front of the black ring of the tube shaft. The machine was started the countdown of the measurement as soon as the tube was put in the fertility box. After the first tube was removed from the shaft, 12 drops substrate was added in tube two and was carried out the steps explained above again and (5 min) waiting time was displayed at the end of the second tube measurement.

After pressing Enter, tube one was Shacked gently to mix liquid (avoid foaming!) and inserted into the device again. Once again note the correct position the measurement was carried out a last second. The measurement was ended with "Put tube back into rack" and the measurement result was appeared as the concentration stated in ng/ml, the usual unit of the hormone progesterone. The color was also clearly seen in the sampled tubes. The result was recorded, as the device does not save it.

3.3. Methods of Data Analysis

3.3.1. Breeding practice

All the data were fed to Ms-Excel (2007). Breeding practice (qualitative data survey) data were analyzed for descriptive statistics using frequency procedure and cross tabulation of SPSS version 16.1 was used. For quantitative data obtained from the recall survey general linear model procedure of statistical analysis system SAS 9.1(2003) was used to evaluate the effect of production system difference on various performance related parameters of dairy cattle (such as milk yield, lactation length, Age at first calving, Days open, Calving interval, Reproductive life, Age at maturity of a male cattle and others.

Model used for Productive and reproductive performance

$Y_{ij}=\mu+h_i+bj+hb_{ij}+\varepsilon_{ij}$

Where $Y_{ij=}$ the response variables (milk yield, lactation length, AFC, CI, DO, RL, male cattle age at maturity)

μ= overall mean

$h_{i=}$ Fixed effect of i^{th} production system(i=2, rural and per-urban)

b_j=Fixed effect of j_{th} breed(j=local and cross)

hb_{ij}=Production system and breed interaction and e_{ij}=residual error

In trait preference ranking method, index was computed using weighed averages and indexes were ranked using auto ranking with MS-Excel 2007.The following formula was used to compute index as employed by (Musa et al 2006):

Index = $R_n \times C_1 + R_{n-1} \times C_2 ... + R_1 \times C_n/\sum(R_n \times C_1 + R_{n-1}\times C_2 + ... + R_1 \times C_{n)}$

Where, R_n = the last rank (example if the last rank is 8^{th}, then R_n = 8, R_{n-1} = 7, R_1 = 1).

C_n = percent of respondents in the last rank, C_1 = percent of respondents ranked first

3.3.2. Mass estrus synchronization and single and double shot of prostaglandins

Proc freq procedure of SAS 9.1(2003) was used to analyze data obtained from mass synchronization and prostaglandin evaluations. The effect of wereda, age, parity, BCS, dam breed, bull, year and others to conception rate and number of service per conception were investigated using x^2–test of kruskal-wallis test option. The result was summarized and presented by percentages.

Models for evaluation of mass synchronized dairy cattle were presented as fellows.

$Y_{ijklmno}= \mu + w_i + d_j + b_k + p_l + y_m + a_n + i_o + e_{ijklmno}$

Where $Y_{ijklmno =}$The response variables=Pregnancy diagnosis (positive and negative)

μ= Overall mean

$w_{i=}$ Fixed effect of i^{th} wereda (i=3, Laelay michew, Adwa and Ahferom)

d_j= Fixed effect of j_{th} dam breed (j=Local, Begait and Holstein cross)

$b_{k=}$ Fixed effect of k^{th} body condition

p_l= Fixed effect of l_{th} parity

$y_{m=}$ Fixed effect of m^{th} year (m=2, 2012 and 2013)

a_n= Fixed effect of n^{th} AI technician

i_o= Fixed effect of bulls and $e_{ijklmno}$=residual error

Model for evaluation of single and double shoot of prostaglandins

$Y_{ijklmno}= \mu + w_i + d_j + b_k + p_l + a_m + i_n + s_o + e_{ijklmno}$

Where $Y_{ijklmno =}$ the response variables (The response variables=Pregnancy diagnosis (positive and negative)

μ= Overall mean

$w_{i=}$ Fixed effect of i^{th} wereda (i=3, Laelay michew, Adwa and Ahferom)

d_j= Fixed effect of j_{th} dam breed (j=Local, Begait and Holstein cross)

$b_{k=}$ Fixed effect of k^{th} body condition

p_l= Fixed effect of l_{th} parity

a_m= Fixed effect of n^{th} AI technician

i_n= Fixed effect of bulls, s_o =Fixed effect of prostaglandin shoot and $e_{ijklmno}$=residual error

Conception rate are estimated from the proportion of pregnancies confirmed by rectal examination of genital tract at day 60 of post insemination among the total number of cows/heifers inseminated artificially with frozen semen at a specified period of time (khatun *et al.*, 2014).

$$\text{Conception rate} = \frac{\text{No. of cows/heifers pregnant}}{\text{No. of cows/heifers inseminated}} \times 100$$

$$\text{Number of service per conception} = \frac{\text{Total number of service}}{\text{Total number of cows conceived}}$$

3.3.3. Progesterone profile analysis

The progesterone levels in milk samples were determined through hormonost maicrolab farmers test, using the kit method. Progesterone concentrations ≥16 ng/ml were considered as 'pregnant', indicating the presence of corpusluteum, <16 ng/ml were considered as 'non pregnant', while those ≤3ng/ml indicating absence of luteal activity (follicular phase or anoestrus). The trend of progesterone profile for each cow during the sampling days was analyzed using SPSS version 16. Average progesterone profile for each sampling day and cows were analyzed using general linear model (GLM) of SAS 9.1 (2003)) and expressed as mean ± SE.

Model for progesterone profile

$Y_{ij}=\mu+l_i+dj+\varepsilon_{ij}$

Where $Y_{ij=}$ the response variable (progesterone concentration)

μ= overall mean

$l_{i=}$ Fixed effect of i^{th} lactating cow

d_j=Fixed effect of j_{th} days

e_{ij}=residual error

The accuracy of positive pregnancy diagnosis was calculated as percentage of cows with elevated progesterone concentration at day 18-24 that were subsequently confirmed pregnant by rectal examination at day 60 post insemination. The accuracy of negative pregnancy diagnosis was calculated as percentage of cows with low progesterone concentration at day 18-24 that were subsequently confirmed to be non pregnant by rectal examination at day 60 post insemination(Snedecor, 1967).

$$\text{Accuracy of positive pregnancy} = \frac{\text{Confirmed pregnant by rectal palpation}}{\text{Percentage of cows with elevated p4 level}}$$

$$\text{Accuracy of negative pregnancy} = \frac{\text{Confirmed negative by rectal palpation}}{\text{Percentage of cows with low p4 level}}$$

4. RESULT AND DISCUSSION

4.1. Household Member and Educational Level of Household Heads

The results on average household numbers of respondents are presented in table 2. The survey revealed that the total average number of household member by gender was 3.16 and 2.91 male and female, respectively. Rural farmers had more household members of male and female than per- urban farms. This is in agreement with the report of ESAP (2002) for the case of Eastern Ethiopia. The dominance of male household heads reported here is in agreement with results published by Azage (2004) for Addis Ababa, Ethiopia.

The results on educational level of respondents are presented in table 2. The result showed that proportion of illiterate household heads was estimated as (50%, 30%) and (65.5%, 51.9%) for rural and per-urban for male and female household heads, respectively. Male headed household were higher in proportion of educational level as compared to female headed household heads in both rural and per-urban areas. This study is consistent with the result of (Yitaye, 2008). It could be argued that, educated households tend to use modern method of rearing like milk production through crossbred cattle and artificial insemination.

Table 2. Average Household number of the respondents in the study area

Farming type	**Male**		**Female**		
	N	Mean±SD	N	Mean±SD	P value
Rural	113	3.23±1.48	113	3.04±1.41	0.41
Per-urban	67	2.92±1.36	67	2.88±1.52	0.86
Total	180	3.16±1.46	180	2.91±1.42	

Where, N is the number of observation, SD is standard deviation

Table 3. Frequency and percent of educational level of the respondents in the study area

Education level	Male				Female				Total			
	Rural		Per-urban		Rural		Per-urban		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%
Illiterate	42	50	12	30	19	65.5	14	51.9	54	42.5	33	58.9
1-7	31	36.9	22	55	10	34.5	13	48.1	53	42.7	23	41.1
>7-12	11	13.1	6	15	0	0	0	0	17	13.7	0	0
Total	84	100	40	100	29	100	27	100	124	100	56	100

Where, N is the number of observation

4.2. Household Resource

The land holding of the respondent household is presented in Table 4. Average land holding for crop was 0.66 ha own and 0.17ha rented. About 0.03 ha, 0.05ha and 1.07 ha land was allocated for grazing and forage production that could be own, rented and communal land, respectively. This low private and rented land allocation for grazing might be attributed to the availability of communal grazing land. Average irrigated land holding was 0.14ha and 0.02 ha for own and rented respectively.

The average land holding for crop, grazing and forage and irrigated land were 0.51, 0.13 and 0.08 ha and 0.32, 0.63, 0.9 in the rural and per-urban areas respectively. The household resource in the rural area showed that nearly 47.8% land was used for crop production and the remaining 43.2% and 9.10 % of land was used for natural pasture and irrigation respectively. This result indicated that land holding for crop in rural area was higher than in per-urban, but land for grazing and forage and irrigation was higher in per-urban than rural areas. The reason might be in per-urban areas the land for farming is limited due to urbanization and availability of water and knowledge about irrigation is higher in per-urban than rural in the study area. The present study is consistent with Zemenu (2014) reported as land holding for crop in the rural areas are higher than other land pattern use in Debremarkos districts.

Table 4. Landholding of the household in rural and per-urban areas (ha)

Land allocation	Rural		Per-urban		Total	
	N	Mean±SD	N	Mean±SD	Mean±SD	P value
For crop		0.51±0.21		0.32±0.33	0.42±0.69	0.01
Own	113	0.79±0.75	67	0.520.±56	0.66± 0.69	0.01
Rented	113	0.22±0.44	67	0.12±0.27	0.17± 0.38	0.10
Grazing & forage		0.13±0.34		0.63±0.18	0.38±0.27	0.04
Own	113	0.01±0.04	67	0.04±0.13	0.03± 0.09	0.05
Rented	113	0.06±0.66	67	0.03±0.24	0.05± 0.54	0.07
Communal	113	0.32±0.87	67	1.82±0.37	1.07± 3.41	0.004
Irrigated land		0.08±0.08		0.09±0.09	0.08±0.13	0.50
Own	113	0.13±0.21	67	0.15±0.15	0.14± 0.18	0.35
Rented	113	0.02±0.09	67	0.02±0.09	0.02± 0.09	0.71

Where, N is the number of observation, SD is standard deviation

4.3. Livestock Holding

The average number of livestock holding was described in (Table 5). The proportion of local and crossbred dairy cattle showed slight difference which was 0.30 and 0.15 in dry cow and 0.25 and 0.18 in lactating cow respectively. Local dry and lactating dairy cattle of rural were slightly higher than local dry and lactating dairy cattle of per-urban areas. However, the crosses were slightly lower in rural areas than per-urban areas. The study revealed that number of local bulls and oxen (0.46, 1.4) in rural areas was higher than local bulls and oxen (0.3, 0.8) in per urban areas. The observed variation for oxen and bull holdings of both locations were probably due to the fact that the rural households give more attention to oxen as source of draught power for crop production and bulls for natural mating of their dairy animal. In the present study there was a significant difference ($p \leq 0.05$) between breeds. Local dry cow, local bull and local oxen were higher than cross dry cow, cross bull and cross oxen in the study area. The average livestock holding per household reported in the present study (4.33 TLU) was lower than those reported by Abdinasir (2000) for Arsi area which was 11.86 TLU.

Table 5. Average number of livestock per house hold by breed in rural and per-urban areas

Animal type		Rural(mean ±SE)	Per-urban (mean ±SE)	Total
Cattle		3.58	2.84	3.21
Calves (< 1 yr)	-Local	0.08± 0.58	0.08±0.04	0.08±0.04
	-Cross	0.06±0.47	0.13±0.04	0.09±0.04
Heifer	-Local	0.18± 0.61	0.14±0.04	0.16±0.04
	-Cross	0.12±0.60	0.14±0.04	0.13±0.04
Bull	-Local	0.46±0.03	0.30±0.48	0.40 ± 0.03^{a}
	-Cross	0.19±0.03	0.10±0.34	$0.15\pm0\ .03^{b}$
Oxen	-Local	1.40 ± 0.80^{a}	0.80 ± 0.98^{b}	$1.1\pm0\ .05^{a}$
	-Cross	0.13 ±0.43	0.03±0.17	0.08 ± 0.05^{b}
Dry cow	-Local	0.30±0. 54	0.25±0.50	0.28 ± 0.03^{a}
	-Cross	0.15±0.55	0.18±0.42	0.16 ± 0.03^{b}
Lactating cow	-Local	0.24±0.08	0.23±0.10	0.24±0.03
	-Cross	0.27±0.08	0.46±0.10	0.34±0.0.3
Total	Local	2.66	1.8	
	Cross	0.92	1.04	
Sheep		0.34±0.54	0.21±0.41	0.29±0.34
Goat		0.39 ± 0.7^{b}	$0.58^{a}\pm0.44$	0.26±0.36
Equines		0.57 ± 0.44^{a}	0.23 ± 0.13^{b}	0.44±0.06
Poultry-Local		0.03±0.28	0.02±0.37	0.03±0.23
-Cross		0.01±0.29	0.01±0.37	0.01±0.23
Beehive-Traditional		0.24±0.08	0.30±0.11	0.21±0.06
-Modern		0.12±0.08	0.36±0.11	0.26± 0.06
Total		4.92	3.89	4.33

Where, N is the number of observation, SE is standard Error

Letters different in row are non significant (p≥0.05) for production system and in the column for breed.

4.4. Assessment of Breeding Practice

4.4.1. Farming system

From the survey result the farming system of farmers (table 6) in the study area was 91.1% mixed type of production, 6.7% livestock production and 2.2% crop production. Most of the farmers were practiced mixed type of production of farming system. This result indicated that households in the study area depends their livelihood both in animal production and crop production.

Farmers depend in livestock production for their livelihood in per urban was higher than rural areas (Table 6). Some farmers in per urban might not have land for crop cultivation so their life depends only in livestock rearing in the study area.

Table 6. Frequency and Percent of farming system adopted by respondents in the study area

Farming type	**Rural**		**Per-urban**		**Total**		**X^2**	**P value**
	N	%	N	%	N	%	2.81	0.245
Livestock production	5	4.4	7	10.45	12	6.7		
Crop production	2	1.8	2	2.98	4	2.2		
Mixed production	106	93.8	58	86.57	164	91.1		
Total	113	100	67	100	180	100		

Where, N is the number of observation

4.4.2. Purpose of keeping dairy cattle

The farmers keep cattle for multiple uses. Farmers keep dairy cattle for, milk consumption, generating income, breeding and milk consumption together. However, farmers attached greater importance to generating income (35.6%) and feeding the family (milk consumption) (32.2%) than any other stated reason (Table 7). The group discussion responded that farmers keeping Friesian and jersey breeds give slightly higher priority to milk production for cash income, whereas those keeping local cattle breeds give higher priority to milk production for feeding the family. Purpose of keeping dairy cattle in this survey is in line with Bebe (2003) stated as farmers attached greater importance to generating income and feeding the family than any other stated reason.

Table 7. Frequency and percent of Purpose of keeping dairy cattle

Purpose	Rural		Per-urban		Total		X^2	P value
	N	%	N	%	N	%	33.63	0.001
Milk consumption	48	42.48	10	14.93	58	32.2		
Milk consumption & breeding	22	19.47	7	10.45	29	16.1		
Generating income	29	25.66	35	52.24	64	35.6		
Generating income & breeding	3	2.65	12	17.91	15	8.3		
Breeding	11	9.73	3	4.48	14	7.8		
Total	113	100	67	100	180	100		

Where, N is the number of observation

4.4.3. Husbandry management

The interviewed households indicated that crop residue was the most common feed resource of dairy in the study area. Hay, wheat bran, hatela and sasbania and lucinia was also the feed source for livestock in the area. Most of the household was tied their cattle around their home and feed their dairy with cut and carry system. There was no free grazing system in the study area. Wheat bran was used in per-urban households than rural households due to availability of cross breed dairy cattle and input supply.

The survey indicated that 21.1%, 50% and 28.9% of households responded that their dairy cattle were taken water from pond, river and pipe water respectively. Majority of the household revealed that the water obtained from the river was not clean water.

48.9 % of the household said that the average distance of watering dairy cattle estimated to be less than 1km from their home and 41.7 and 9.4 % households responded watering point was at home and 1-5km far away from their home respectively. The watering point at home indicated that dairy cattle was not let free grazing. The frequency of cleaning the house of dairy cattle in the study area was 51.1%, 35.0% and 13.9% for daily, weekly and monthly respectively.

The result revealed that 68.3% of the respondents did not have animal health problems and all respondents said that they get veterinary service. The result of the survey indicated that regarding disease prevalence, the major animal disease identified in the area was anthrax, bovine Pastorolosis, black leg, mastitis, and dystocia. All households were vaccine their animal, but they don’t know for which disease was given the vaccine.

4.4.4. Sources of dairy foundation stock

The study showed that 69.4% of the household purchased their first dairy cow, 10% actually obtained from gift of their family’s stock, 1.1% upgrade and 19.4% of the households get their foundation dairy stock from their own stock. Purchased dairy (69.91% and 68.66%) was the main foundation stock followed by own (20.35% and 17.91%) in both rural and per-urban areas. This result shows that smallholder dairying developed independently of direct project donations and without the long process of upgrading indigenous zebus to exotic dairy breeds. The higher proportion of purchased dairy cattle indicated that their important role in the foundation of smallholder dairying in the study area. Foundation dairy stock source in this study is in line with result of Bebe (2003) reported purchased dairy is the highest source for foundation stock (83%) in Kenyan highlands.

Table 8.Frequency and percent sources of foundation dairy stock as perceived by farmers

Foundation stock	**Rural**		**Per-urban**		**Total**		**X^2**	**P value**
	N	%	N	%	N	%	2.58	0.46
Purchased	79	69.91	46	68.66	125	69.4		
Gift	9	7.96	9	13.43	18	10		
Upgrading zebu	0	0	2	1.77	2	1.1		
Own farm	23	20.35	12	17.91	35	19.4		
Total	113	100	67	100	180	100		

Where, N is the number of observation

4.4.5. Mating type of dairy cattle

Farmers use a diversified reproductive technologies and mating type in the study area (Table 9). The survey revealed that 42.77 %, 22.22% and 35% of interviewed households used artificial insemination, artificial insemination with estrus synchronization and natural mating respectively. This result indicated that Artificial insemination was dominantly used in the study areas.

The rural and per-urban dairy production system have a different practice in using reproduction technologies in which 40.7% rural farmers and 46.26% per urban areas practiced only artificial insemination, while 15.04% and 34.32% of respondents practiced AI with estrus synchronization in rural and per-urban farms respectively. The survey has also revealed that, 19.40% of per urban farms and 44.24% of rural farms depended on natural and uncontrolled mating system. There was a tendency that, breeding practices have shifted from natural mating to improved mating system in the study area. Artificial insemination alone and artificial insemination with synchronization was higher in per-urban households than rural households, where as natural mating was higher in rural households than per-urban households (Table 9). This result indicated that per-urban households were more aware than rural households about the advantage of artificial insemination and estrus synchronization due to access to artificial insemination services. The accessibility to reproductive technologies and the high market demand for milk might have been contributed to the more use of AI and synchronization in per-urban areas.

Farmers practice different options to reverse failure on conception. Most of the respondent practice natural mating if AI service did not bring conception while, some of them practice AI repeatedly. There are a number of factors contributing to unsuccessful pregnancy after insemination. As indicated by group discussion and key informants the reason for failure of insemination in the study area was heat detection problem, disease problem, performance of AI technicians and distance of AI center to farmers. This is in agreement with the result of (Desalegn, 2008) in Ethiopia. The present study revealed that, 78.8% farmers were satisfied with the overall service of the AI technician and 21.2% were not satisfied. Most of farmers communicate the AI technicians for services via phones and the result indicated that 68.6% of the respondents call with phone when they want to AI technicians for insemination.

The overall perception of farmers for estrus synchronization was 54.7%, 26.5%, 14.5% and 4.3% low, medium, high and very high respectively. This result indicated that more than half of the households responded estrus synchronization was low in its conception rate in the study area. Poor body condition, shortage of feed, thawing problem, time missing for insemination, huge number of animals inseminated by the inseminator might have contributed to low conception rate. Few farmers have attributed the poor conception to the poor quality of semen, problem in semen handling, performance of the inseminator and low awareness of farmers on the technology. There was also poor awareness on the advantage of synchronization in which some farmers understand injection of hormones similar to insemination which did not bring for insemination and others bring sterile and non-cyclic animals for $PGF2\alpha$ treatment. Hence, there is a need to create awareness of the farmers through demonstration for a wider adaptation of the technology.

The study indicated that educational status of the households directly related to perception of farmers in estrus synchronization. Illiterate male and female households have the highest percentage (Table 11) for low perception of synchronization in the study area.

The opportunities for AI and synchronization of dairy production obtained from group discussion in the study area were presence of veterinary service, equipped AI technicians and experts, availability of cattle population, extension service and good market demand for milk production.

Table 9. Mating type of dairy cattle in the study area

Mating	Rural		Per-urban		Total		X^2	P value
	N	%	N	%	N	%	14.76	0.001
AI without synchronization	46	40.7	31	46.26	77	42.77		
AI with synchronization	17	15.04	23	34.32	40	22.22		
Natural mating	50	44.24	13	19.40	63	35.00		
Total	113	100	67	100	180	100		

Where, N is the number of observation

Table 10. Perception of farmers for estrus synchronization

Perception	Rural		Per-urban		Total		X^2	P value
	N	%	N	%	N	%	7.39	0.06
Low	32	58.18	32	51.61	64	54.7		
Medium	22	35.48	9	16.36	31	26.5		
High	7	11.29	10	18.18	17	14.5		
Very high	1	1.61	4	7.27	5	4.3		
Total	62	100	55	100	117	100		

Where, N is the number of observation

Table 11. Educational level of households in acceptance of estrus synchronization

Sex of household	Educational level	Perception of farmers in estrus synchronization				X^2	P value
Female		Low	Medium	High	Very high	4.10	0.13
	illiterate	62.50	29.20	8.30			
	1-7	40.00	26.60	33.33			
Male						8.60	0.20
	illiterate	58.82	32.35	8.82			
	1-7	58.62	13.80	17.24	10.34		
	>7	40.00	33.33	13.33	13.33		

All the respondents said that semen that used for insemination was selected by the artificial insemination technician rather than farmers. The result of the survey indicated that 94.4 % of the households were not aware about problem of inbreeding and 5.6% of them were aware about problem of inbreeding in the study area. The households responded that weak calves, small sized animal, poor resistivity for disease and decrease productivity were the main problems of inbreeding in the study area.

Table 12. Respondents that aware about problem of inbreeding in the study area

Knowledge of inbreeding	**Rural**		**Per-urban**		**Total**		**X^2**	**P value**
	N	%	N	%	N	%	0.74	0.39
Yes	5	4.42	5	7.46	10	5.55		
No	108	95.58	62	92.54	170	94.45		
Total	113	100	67	100	180	100		

4.4.6. Source of breeding bull

The farmers have different source of bull for mating (Table 13). The households in study area obtained breeding bull from neighbors, own farm and village as responded by 61.4%, 21.3% and 17.3% of farmers, respectively. The present study is in agreement with previous studies who reported 21.6% farmers keeping bulls on their farm (Gitau *et al*., 1994).The bulls kept in own farm are shared and recycled in communities. It has been argued that, few farmers keep their own bulls and breeding stocks which are recycled within the community with small herd size, and there are possibilities of increasing inbreeding rates in the population (Bebe et al., 2000). Bull obtained from neighbors was higher (67.5%) in Per-urban households than rural households (58.62%) attributed to high availability of bulls in rural areas for their multiple uses.

All farmers in the study area castrate their bull to use them for plouging and control breeding. The farmers also perceived that if the bulls are castrated, it might respond to feeding and be fattened.

Table 13. Frequency and percentage of bull Source in the study areas

Source	Rural		Per-urban		Total		X^2	P value
	N	%	N	%	N	%	4.74	0.09
Own	23	26.44	4	10	27	21.26		
Village	13	14.94	9	22.5	22	17.32		
Neighboring	51	58.62	27	67.5	78	61.42		
Total	87	100	40	100	127	100		

Where, N is the number of observation

4.4.7. Selection criteria and trait preference of dairy cattle

According to group discussion the main selection criteria of farmers for dairy cattle in the study area were milk yield based on individual performance and pedigree selection. This result is in agreement with a previous study that was conducted in Kenyan Urban dairy production systems where milk is sold on volume basis (Ibrahim and Jayatileka, 2000). Friesian and their cross were the most preferred breeds for high milk yield, which explains their increasing predominance in the smallholder systems. However, local cattle were more favored over Friesian for disease resistance and feeding behavior but not for market value and body weight.

Trait preference as perceived by farmers was rated as milk yield, fertility and body weight from first to third rank, respectively (Table 14 and 15). Feeding behavior, temperament, color and disease resistance were also rated from fourth to seventh in that order. The trait preference of farmers were more or less similar in both rural and per-urban areas which rated milk yield (46%,49.3%), body weight(23%,29.9) and fertility rate (13.3%,8.9%) from first to third, respectively. On the other hand disease resistance was the least preferred (0%, 1.5%) in rural and per-urban farms, respectively. This result indicated that households in the study area gave more attention to market oriented dairy system. Farmers in the study area preferred a dairy cow with high milk production, less feed consumption and with good feed appetite due to shortage of feed in the study areas. High preference for milk yield is common for smallholder farmers who kept cattle primarily for milk production to feed their family and to earn additional income. The result were consistent with the report of Mwacharo and Drucker (2005) and Lanyasunya *et al*. (2006) for smallholder farmers in Kenya and Stein *et al*.(2009) who has studied indigenous cattle breeds kept by smallholder farmers in Ethiopia. However, the present findings are inconsistent with the studies of Kassie *et al*. (2009) under smallholder Horro cattle owners in the central Ethiopia where milk is only used for home consumption and selling milk is considered as social taboo. This indicates the fact that, trait preference is driven by the breeding objective, product use and purpose of keeping livestock.

Table 14. Trait preference of farmers for dairy cattle in rural area

Parameter	**Rural**								
	1st	2nd	3rd	4th	5th	6th	7th	Index	Rank
Milk yield	46.0	24.8	17.7	6.2	2.7	0	2.7	0.21	1
Fertility	13.3	45.1	21.2	12.4	7.1	0.9	0	0.19	2
Body weight	23.0	8.9	28.3	20.4	7.1	8.0	4.4	0.17	3
Feeding behavior	13.3	8.0	15.9	35.4	17.7	8.8	0.9	0.16	4
Temperament	3.5	6.2	11.5	21.2	37.2	18.6	1.8	0.13	5
Color	0.9	3.5	4.4	5.3	21.2	51.3	13.3	0.09	6
Disease resistance	0	4.4	0.9	0.9	6.2	10.6	77.0	0.05	7

Index=the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for individual variables divided by the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for all variables.

Table 15.Trait preference of farmers for dairy cattle in per-urban areas

Parameter	Per-urban								
	1st	2nd	3rd	4th	5th	6th	7th	Index	Rank
Milk yield	49.3	34.3	6.0	8.9	1.5	0	0	0.22	1
Fertility	8.9	26.9	35.8	19.4	3.0	3.0	0	0.18	2
Body weight	29.9	13.4	22.4	11.9	8.9	8.9	4.5	0.18	2
Feeding behavior	4.5	3.00	19.4	28.4	20.9	20.9	3.0	0.13	3
Temperament	1.5	16.4	10.5	17.9	28.4	20.9	4.5	0.13	3
Color	1.5	3.0	4.5	7.5	34.3	40.3	8.9	0.10	6
Disease resistance	1.5	3.0	3.0	6.0	3.0	6.0	77.6	0.06	7

Index=the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for individual variables divided by the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for all variables.

4.4.8. Productive and reproductive performance of dairy cattle

The productive and reproductive performance has been presented in table 16.The result of the survey showed that average daily milk production of local dairy cattle was 1.97 liter per cow per day and 7.10 liters per day per cow for crossbred dairy cattle and have lactation length of 7.36 and 9.28 months for local and cross dairy cattle, respectively. The frequency of milking was two times per day, which is in the early morning and late evening. The average daily milk production of local (2.47) and cross (7.89) cattle in per-urban was statistically significant from rural areas (1.72) and (6.52) respectively

The result in this study was lower than the generally accepted 305 days of lactation length for high grade and crossbred cows (Peixoto, *et al*).The Lactation length obtained for local cattle in this study was longer than (5.9 months) result of Tesfaye (2007) in Metema district. The Lactation length of the indigenous cows observed in this study was similar with the national average (7 months) (CSA, 2005) and with the result of (Belay, 2012) with 241.67±26.22 days of lactation length, whereas the Lactation length in crossbred cows observed in this study was shorter than(11.7) months reported in the Central Highlands of Ethiopia (Zelalem and Ledin, 2001).

Ages at first calving of local dairy cattle in rural farms (4.09±0.08 years) had a significant difference to per-urban farms (3.78±0.11 at ($p \leq 0.05$), whereas cross bred cattle had no significant ($p>0.05$) difference across locations. This result was in agreement with the study conducted by Gebrekidan *et al* (2012) in urban and per urban areas of central zone of Tigray. However, age at first calving of crossbred in present study was inconsistent with the result of (Belay *et al,* 2012 and Nibret, 2012), (24.3 month 32.4) respectively.

In this study, calving interval (CI) for local and crossbred dairy cattle did not differed significantly ($P>0.05$) across the locations, but has difference between breeds in the location. However, CI tends to decrease as the exotic blood level increased. This might be attributed to genetic difference between the indigenous and exotic breed and less attention given in management to the indigenous breeds as compared to the crosses. The value obtained in the present work is comparable to the result reported for Zebu cattle (between 12.2 and 26.6 months) (Solomon, 2006). It is also comparable with the average value of cross (15.3□0.33 months) reported by Negussie (2006) in Mekelle city. The CI in this study particularly in the per-urban areas was generally longer than the recommended interval of 12 months on different literatures (Kiwuwa *et a*l., 1983). If at all possible, CI should be in the range of 12 to 13 months for cattle Kiwuwa *et al*. (1983) in order to maximize reproductive efficiency and profitability in a dairy herd. The longer CI in this study particularly the rural area could be due to poor heat detection and less access to AI services and poor feeding practices.

In this study the average days open of local and cross dairy cattle was10.94±0.49 and 6.87□±0.62 months, respectively. The average days open of local and cross cow in rural and per-urban was not significantly ($p>0.05$) different (Table 16), But there is a significant difference between breed across production system. Feed shortage, silent estrus and lack of proper heat detection might have contributed considerably to the long days open reported in this study. Average days open in this study is in agreement with result of Azage (1981) for cross dairy cattle (188.8 ± 21) days in central highland of Ethiopia.

The reproductive life time of the breeding bull and female was 7.12±0.05 and 11.20± 0.19 years in the rural, and 7.150.07and 11.33±0.24 years in per urban areas, respectively (Table 14). Though there was no statistically significant difference for male and female of both production system. Local bull reproductive life is slightly lower than per-urban that might be attributed to in addition to breeding role of males, they are employed for traction purpose and fattening which shorten their reproductive life in rural.

Sexual maturity of the local bull in the study area was 4.02±0.02years. This result indicated that male animals reach their maturity at latter times. The reason might be due to genetics and poor management practices. This result is in line with the report of Abebe (2009) and Dejene (2014), that have reported 3.7 and 4.2 years age at sexual maturity of male Borona cattle respectively.

Table 16. Productive and reproductive performance of dairy cattle by breed and location

Factors	MY(L)	LL(month	CI(year)	AFC(year)	DO(month)	RLC(year)	RLB(y)	AMM(y)
Production system								
Rural	4.13±0.21[b]	8.39±0.26	1.50±0.05	3.40±0.09	8.83±0.09	11.20±0.19	7.12±0.05	4.02±0.02
Per-urban	5.19±0.25[a]	8.25±0.32	1.50±0.04	3.57±0.07	8.97±0.09	11.33±0.24	7.15±0.07	3.94±0.04
Breed								
Local	1.97±0.1[b]	7.36±0.27[b]	1.66±0.04[a]	3.99±0.07[a]	10.94±0.49[a]			
Cross	7.11±0.36[a]	9.28±0.31[a]	1.33±0.05[b]	3.01±0.10[b]	6.87±0.62[b]			
Prod*Breed								
Rural*local	1.75±0.24[d]	7.70±0.30[b]	1.65±0.04[a]	4.09±0.08[a]	10.78 ±0.57[a]			
Rural*cross	6.52±0.33[b]	9.09±0.42[a]	1.35±0.07[b]	3.00±0.14[b]	7.35±0.85[b]			
Per-urban*local	2.47±0.35[c]	7.03±0.45[b]	1.68±0.06[a]	3.78±0.11[a]	11.25±0.78[a]			
Per-urban*cross	7.89±0.37[a]	9.48±0.45[a]	1.30±0.07[b]	3.03±0.15[b]	6.34±0.9[b]			

Where AFC= age at first calving, CI= calving interval, DO=days open, RLC= Reproductive life of cow, RLB=Reproductive life of bull, AMM= Age at maturity of male cattle, y=year
Means with the same letter in columns are non significant ($p \geq 0.05$)

4.4.9. Record keeping

There were 6.2% of rural areas and19.4% of the per-urban farms practiced keeping records about input costs and output prices. The absence of record keeping in almost all rural farms and in (80.6%) per-urban area farms is indicative of lack of awareness of farm owners on the benefits of record keeping in dairy farm operations. The type of recorded hold by farmers in the study area were price of purchased cattle, feed cost, medication cost, labor cost and revenues obtained from sale of bulls, male calf, milk sale, year of birth etc. Recording system in the study area is an indication of good breeding program. To increase this recording system extension agents should give training and practically show how and what to record. Farmers should practice synchronization and AI as it induces good record keeping of dates of heat, breeding, pedigrees, etc. This will aid in herd improvements and enable the owner to make better culling decisions.

4.5. Evaluation of Mass Estrus Synchronization

4.5.1. Conception rate and Number of service per conception

From a total of 701 AI done, 266 became pregnant giving an overall CR of 37.95% with 2.63 number of service per conception. This result of conception rate is lower than the result of Azage *et al*. (2013) and higher than the results of Desalegn (2008) and Nordin (2004) which have reported CR of 60% and 32%, respectively. This might be due to practicing of synchrony of ovulation and fertilization as the existing follicles were influenced the next wave of follicles during induction.

The current result is similar with those of some studies (37% and 39%) that use PGF2α treatment and visual detection of estrus (Jordan *et al*, 2002, Peeler *et al*, 2004). It is also consistent with number of studies based on the analysis of reproductive records of a large number of dairy farms that have reported conception rate at first insemination and ranged from 37.1% (Mayne *et al*., 2002) to 40.7% (Galon *et al*., 2010).

4.5.1.1. Effect of wereda and breed on conception rate and NSC

The conception rate in different breeds of cow did not show a significant effect (Table 17). The conception rate and NSC of Begait and Holstein cross were relatively higher than local cattle in the present study, however the difference is not statistically significant ($p>0.05$).The overall and within group conception rate percentage in Begait (39.7%) and Friesian cross (38.7%) cows/heifer s were relatively higher than that of local (37.4%) cows. The reason might be attributed to the difference in management practices Holstein cross and Begait were given more attention than local cows in the study area. Cross breed Conception rate is higher than local breeds in Tanzania (Asimwe, 2007) consistent with the present study.

Wereda showed a significant ($p<0.05$) effect on CR. Both Ahferom and Adwa wereda showed higher CR and NSC than Laelay michew. The reason might be lack of awareness creation in Laelay michew about the estrus synchronization during the study period. Most of the farmers answered during the survey they provided non cycling cows and not gave birth for a long period of time. In other case the experience, commitment and acceptance of the technology by artificial insemination technicians might be attributed to the difference in conception rate in the study area.

Table 17. Effect of wereda and breed on conception rate and NSC

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
Wereda						18.04	0.0001
Adwa	298	165	133	44.63	2.24		
Ahferom	234	143	91	38.89	2.57		
L/michew	169	127	42	24.85	4		
Breed						0.10	0.9494
Holstein cross	86	53	33	38.37	2.6		
Begait	63	38	25	39.68	2.5		
Local	552	344	208	37.68	2.65		
Over all	701	435	266	37.95	2.63		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /cows conceived

4.5.1.2. Effect of age on conception rate and NSC

The total conception rate and the variation in relation to different age group were shown in table 18. The conception rate increased with increasing age from 2 years until age 7 years but decreased from age group of more than 8 years (table 18). This result is in agreement with the report of khatun (2014) in which decreased conception rate was observed after age eight in dairy cattle. This result showed that CR in middle age (4-7) was higher than early and late ages. The highest CR was observed in age seven followed by age six and least in age of nine.

4.5.1.3. Effect of parity on conception rate and NSC

The conception rate and number of service per conception in different parity of cows inseminated in the present study is shown in (table 18). Conception rate and number of service per conception with respect to different parities ranged from 32 to 41.48% and 2.41 to 2.73 respectively. Cows received insemination at parity 2 showed highest conception rate (41.48%) and lowest NSC (2.41) and cows received insemination at parity 4 showed lowest conception rate (32%) and highest NSC (2.73). There were no significant difference between them on conception rate and NSC.

Conception rate increased gradually from the 0 parity to the 3rd parity and then decreased in the subsequent parities in the present study. Similarly Fengxum (1997) observed higher CR in 1st, 2nd and 3rd parities than in later parities. Biochard and Manfredi (1994) also reported that the CR in 1st parity of cows was highest (54%) and the lowest in 7th parity of cows (38%). CR tended to increase with increased parity number which was similar to other studies reported by Chung *et al*. (2001) and Hla *et al*. (2001).It is also quite similar to the report by Gwazdauskas *et al.* (1981) where CR is significantly higher in cows of first than of fourth parity.

4.5.1.4. Effect of body condition score on conception rate and NSC

Body condition score (BCS) is an indicator of the nutritional status of the cow and exerts a mark influence on fertility (Randel 1990). Generally, it is reported that poor reproductive performance is associated with poor body condition. In the present study, cows with BCS of 4 showed higher conception rate (41.51%) and lower NSC (2.40) than BCS of 3 and 5. There was significant difference between BCS of 3 and 4 in conception rate. This result indicated that BCS 4 at AI appeared to be optimum for improved fertility in dairy cattle. This result is in agreement with the report of Shamsuddin *et al*. (2001) CR is lower (36%) when cows are inseminated at BCS of 1.0 –2.0 than at 3.5–5.0 (60%).

Table 18. Effect of age, parity and BCS in CR and NSC

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
Age						2.99	0.8857
2	12	8	4	33.33	3.00		
3	63	41	22	34.92	2.86		
4	188	118	70	37.23	2.68		
5	154	96	58	37.66	2.65		
6	135	79	56	41.48	2.41		
7	88	51	37	42.05	2.38		
8	47	32	15	31.91	3.13		
9	14	10	4	28.57	3.50		
Parity						1.52	0.8220
0	314	199	115	36.67	2.73		
1	168	105	63	37.5	2.66		
2	135	79	56	41.48	2.41		
3	59	35	24	40.68	2.45		
4	25	17	8	32.00	3.12		
BCS						6.31	0.0426
3	245	167	78	31.84	3.14		
4	436	255	181	41.51	2.40		
5	20	13	7	35.00	2.85		
Over all	701	435	266	37.95	2.63		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /cows conceived

4.5.1.5. Effect of cervix status on conception rate and NSC

Open cervix after prostaglandin treatment has highest conception rate (39.62%) and lowest NSC (2.52) than partial and closed cervixes. Animals with closed cervix has the lowest conception rate (22.64%)and highest NSC (4.41).This result indicated that those animals with open cervix responded for prostaglandin while cows with closed cervix did not respond and was not show sign of estrus. 92.43% of cows responded to prostaglandin treatment after PGF2α injection. The reason of conceived cows with closed cervix might be show sign of estrus after some days and mated with bull in the surroundings.

Table 19. Effect of cervix status after prostaglandin injection on conception rate and NSC

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
						5.89	0.0524
Cervix after prostaglandin treatment							
Open	520	314	206	39.62	2.52		
Partial	128	80	48	37.50	2.66		
Closed	53	41	12	22.64	4.41		
Over all	701	435	266	37.95	2.63		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /cows conceived

.

4.5.1.6. Effect of year and AI technician on conception rate and NSC

The result presented in table 20 showed that there was a significant difference ($p<0.05$) in conception rate between 2012 and 2013 year synchronized and inseminated cows. In year of 2013, inseminated cows were higher in conception rate (43.93%) with lower number of service per conception (2.27) than year 2012.This may be due to in the year 2012 there were less awareness creation in the farmers about the technology and lack of follow up in the experts until the cow showed sign of estrus during the mass synchronization. The possible reasons for the observed annual variability and marked increase in the NSC during these years could be annual climatic change in relation to feed availability and different management parameters.

The result (Table 20) showed that technician 6 scored highest CR with lowest number of service per conception while technician 3 and 4 show the least performance of all technicians. There was significant difference in CR due to AI technicians; the magnitude of CR obtained by each technician reflected his degree of skill and experience and commitment in the AI technique. The reason may be CR can be increased when AI was carried out by technician with longer duration of AI training. This implied that longer AI training duration improved the skill of the AI technician. The less skillful AI technician, which could be due to the shorter AI training duration, might had caused improper insemination such as depositing semen in the cervix, which thus contributed to the decrease in Conception rate.

Table 20. Effect year and AI technician on conception rate and NSC

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
Year						19.46	<0.0001
2012	248	181	67	27.02	3.7		
2013	453	254	199	43.93	2.27		
Technician						26.74	<0.0001
technician 1	125	58	67	53.6	1.86		
technician 2	48	33	15	31.25	3.2		
technician 3	80	60	20	25.00	4.00		
technician 4	89	67	22	24.72	4.00		
technician 5	234	143	91	38.89	2.57		
technician 6	125	74	51	40.80	2.45		
Over all	701	435	266	37.95	2.63		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /cows conceived

4.5.1.7. Effect of bull on conception rate and number of service per conception

There was significant difference in CR and NSC among bulls in the present study. Bull 10-186 was higher in conception rate(92.31%) and lower in NSC(1.08) followed by bull number

02-051 and bull number 10-204 was lower in conception rate and higher in NSC than the rest of bulls. The variation in CR suggests that the bull exerts influence on fertility.

The difference in bull efficiency might be related with individual performance of the bull, magnitude of the AI technician in which technician with good experience deposit the semen in to the uterus and conception rate increased. Semen handling might be also affecting the efficiency of the bulls. The variation in CR suggests that the bull exerts influence on fertility. The semen of the bull should be evaluated for motility and fertility from production until insemination to improve efficiency of the bull.

This result is in consistent with the report of Nordin (2004), no significant difference between bulls, but agreed with finding of Gwazdauskas *et al*. (1981) varied from 14.3% to 80% in conception rate.

Table 21. Effect of bull on conception rate and NSC

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
						59.71	<0.0001
Bull number							
01-051	26	9	17	65.38	1.53		
02-052	27	18	9	33.33	3.00		
10-186	13	1	12	92.31	1.08		
10-188	46	29	17	36.96	2.70		
10-202	25	14	11	44.00	2.27		
10-204	30	25	5	16.67	6.00		
10-205	37	24	13	35.14	2.84		
10-207	15	9	6	40.00	2.50		
10-217	42	30	12	28.57	3.50		
10-218	16	13	3	18.75	5.33		
10-219	162	101	61	37.65	2.65		
10-220	29	16	13	44.83	2.23		
10-226	15	7	8	53.33	1.87		
10-233	8	3	5	62.50	1.60		
11-201	26	20	7	25.93	4.33		
11-206	54	22	32	59.26	1.69		
11-231	34	27	7	20.59	4.85		
50-199	28	21	7	25.00	4.00		
75-114	43	28	15	34.88	2.86		
75-214	24	18	6	25.00	4.00		
Total	701	435	266	37.95	2.63		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /cows conceived

4.6. Evaluation of Single and Double Shot of Prostaglandins

From the total of 126 PGF2α treated cows 107 (84.9%) cows showed sign of estrus at time of insemination. From those inseminated cows only 55 (51.4%) of cows were pregnant when checked by rectal palpation after 60 day of insemination. The remaining 19 (25.1%) cows showed no sign of estrus at day 0 and those cows were given double injection of PGF2α (Lutalyse) 14 days after the first injection. 17 (89.5%) cows after the second injection showed estrus at day of insemination and were inseminated at timed AI and detected estrus. From the inseminated cows 9 (52.9%) cows were pregnant. This result indicated that those animals which fail to show estrus after the first injection were at early stage of the cycle (1-5) days of estrus cycle and at the second injection they were in the perfect diestrus stage and most of them responded for second injection. So, giving second injection for cows not responded for first injection of PGF2α has complimentary advantage to single injection. But the rest 2(11.1%) cows not responded for both single and double injection might have reproductive problem and animals failing to display estrus after treatment should be further examined to ascertain the reason for absence of estrus.

The median day at which estrus was observed was Day 3 (69.45 hours) with a range of two to 5 days in first injection and 57.88 in second injections. There is significant difference between single and double injection in time of heat, but not for heat response and conception rate in the study area (Table 21). Time of heat after injection in the present study was in agreement with the finding of Watts and Fuquay (1985), the mean interval to estrus was 48 to 72 h when PGF2α was administered on estrous cycle day 5 or day 8 in dairy cows the stage of follicular wave development at the time of PGF2α treatment appears to be the factor determining the time of estrus onset (Tenhagen, 2000). Prostaglandin treatment in the early stage of estrous cycle (first 5 days) was found to be ineffective in causing a luteolytic response in cattle (Lauderdale, 1975). Consequently, a double protocol in which PGF2 α was given at a 7, 11, or 14 day intervals was developed so that cows at a stage in the estrous cycle other than diestrus would have a functional corpus luteum when they received the second PGF2 α dose.

The study concluded that double injection of Prostaglandin has reduced the calving to service period which would eventually reduce calving interval in lactating dairy cows.
In the present study, the estrus response recorded higher (84.9% and 89.5%) in single and double injection than the result of Vankata *et al* (2013) after double injection for lactating Ongele cows. The current result of estrous response are better than those of Amer (2008), who reported that 68.3% of Holstein cows exhibited estrus after the first treatment with prostaglandin and 71.7% after the second treatment.

The current result of conception rate (51.4%) is higher than the finding of Mayne *et al*. (2002) 37.1% and Galon *et al*. (2010) 40.7% based on the analysis of reproductive records of a large number of dairy farms. The result of this experiment is in line with Amer (2008) conception rate after the first injection of prostaglandin was 56.3% and 50.0% after the second injection.

In the present experimental study higher conception rate (51.4%) and lower number of service per conception (1.9%) were observed than the mass synchronization/insemination in study area. The reason might be selection of cows for synchronization were carefully done based on good body condition cows, cyclic animals, farmer with good feed availability and technology acceptance and appropriate breeding season were used. Only one AI technician with good performance on insemination was also used to minimize error between technicians. Cows were inseminated at detected estrus after the treatment of PGF2α especially in the single injection.

As indicated in table (22) except BCS in the experimental study all parameters did not show significant difference in effect of CR and NSC in the study area. The effect of BCS in the experimental study is agreed with the result of mass synchronization which is cows with BCS 4 had higher CR and low NSC and significantly differs to BCS 3 and 5. This result indicated that appropriate BCS of cows during PGF2α treatment is the best solution to increase the efficiency of synchronization. So cows with BCS of 4 with level of (1-5) should be selected for PGF2α injection.

Bull Id have significant difference during mass synchronization but in the experimental study do not significantly differ because handling of semen and thawing were properly done and only 5 bulls were used for this study. The rest parameters (wereda, age, parity) did not show significant difference both in mass synchronization and in experimental study. Even if there is no significant difference Adwa wereda had higher conception rate than Ahferom and L/michew. Similarly cows with age 6 score higher conception rate and lower number of service per conception than other age groups. The study indicated that cows with parity one have higher conception rate than other party groups but not statistically different.

Table 22. Response to PGF2α, time of response, CR and NSC after single and double injection

PGF2α	**Injected**	**In heat**		**Time of response(hr)**	**Inseminated cows**	**NPT**	**PPT**	**CR**	**NSC**
		N	%						
Single	126	107	84.9	69.4	107	52	55	51.4	1.9
Double	19	17	89.5	57.88	17	8	9	52.9	1.9
Total	145	124	85.5	63.64	124	60	64	51.6	1.9
X^2			0.28					0.014	
P value			0.5991	0.02				0.9061	

Where; PGF2α= prostaglandin f 2α, N= Number of cows, NPT= negative pregnancy test, PPT =positive pregnancy test, CR= conception rate, NSC= number of service per conception, cows treated with double injections were those didn't show estrus after single injection

Table 23. Effect of Wereda, Breed, Age, Parity, BCS, and Bull ID for conception rate and NSC for experimental study

Parameter	N	NPT	PPT	CR	NSC	X^2	P value
Wereda						3.65	0.16
L/michew	38	23	15	39.47	2.53		
Adwa	36	14	22	60.11	1.64		
Ahferom	33	15	18	54.55	1.83		
Breed						1.23	0.54
HFC	58	26	32	55.17	1.81		
Begait	6	4	2	33.33**	3**		
Local	43	22	21	48.84	2.04		
Age						2.65	0.76
3	16	7	9	56.25	1.77		
4	16	7	9	56.25	1.77		
5	29	14	15	51.72	1.93		
6	18	7	11	61.11	1.64		
7	10	6	4	40**	2.5**		
8	18	11	7	38.89	2.57		
Parity						3.17	0.53
0	19	10	9	47.37	2.11		
1	33	13	21	61.76	1.57		
2	22	10	12	54.55	1.83		
3	20	12	8	40.00	2.5		
4	12	7	5	41.67	2.4		
BCS						6.61	0.037
3	16	11	5	31.25	3.20		
4	78	32	46	58.97	1.70		
5	13	9	4	30.77	3.25		
Bull ID						1.91	0.75
10-188	52	27	25	48.07	2.08		
10-230	20	8	12	60	1.67		
10-257	19	9	10	52.63	1.9		
50-199	6	4	2	33.33**	3.00**		
50-213	10	4	6	60**	1.67		
Total	107	52	55	51.4	1.90		

NB. Where N=total number animals inseminated, NPT=negative per pregnancy test, PPT= positive per pregnancy test, CR=Conception rate, NSC=Number of service per conception, body condition score (1-5). X^2-Test is only for conception rate and the NSC is obtained from total number of cows inseminated /Total cows conceived

** Excluded from the result, because observations are less than 5

4.6.1. Cost benefit analysis

Attempts were made to determine the benefits of double prostaglandin technique in terms of the advantages in shortening the open period. However, most farms did not have a system for recording production and economic data and several assumptions had to be made in making the calculations. It is obvious that single prostaglandin injection is profitable than double injection. Injection of double PGF2α to cows did not respond to first injection had also profitable (Table 24). Income gained for single and double injection as compared to natural estrus was estimated ETB 54,246 & 4330.9 from an unproductive cow for 21 and 7 open days and extra conception rate (considering mean milk production per day and calf loss) in the study area respectively. As single and double prostaglandin eliminates the extra open days and gained extra 21.4% and 22.9% CR in this study the profit was estimated (ETB 43,694 and 774.9) respectively, so using single and double (for those cows do not responded for first injection) prostaglandin injection was economically advantageous. The conception rate of natural estrus plus artificial insemination was 30% in Ethiopia (Desalegn, 2008).

Profit= Income gained-total cost

Table 24. Cost-benefit analysis on the use of single and double shot of prostaglandin

PGF2α	N	Costs				Total cost	Income gained			Profit
		Prostaglandin	Technician	Semen	Labor		From extra open days eliminate	From Extra CR	Total	
Single	126	10,080	170	252	50	10,552	(4.5*10*21*55)+941.6=52,916.6	1329.4	54,246	43,694
Double	19	3040	340	76	100	3556	(4.5*10*7*9)+73.4=2908.4	1422.5	4330.9	774.9

Where: Single and double prostaglandin eliminates the extra open days as compared to natural estrus plus AI, Milk/cow/day=4.5 litter, Price of milk=ETB10, Price of calf for the 21 and 7 days open= 17.12 and 8.15 respectively, N=Number of cows injected prostaglandin. Extra Conception rate for single and double PG treated cows 21.4% & 22.9 respectively as compared to natural estrus plus AI (30%) Conception rate, Extra days open eliminate for single and double injection =21 days and 7 days respectively

4.7. Pregnancy and Embryonic Mortality from Milk Progesterone Profile

Embryonic mortality is generally defined as loss of the embryo which occurs during the first 45 days of pregnancy, which is the period from conception to completion of differentiation when organ systems develop. Embryonic mortality contributes to reproductive inefficiency because fertility assessed at any point during pregnancy is a function of both conception rate and embryonic mortality (Fricke, 2002).

The result of least square analysis of mean of progesterone profile of cows (table 25) indicated that milk sample taken at day 18 was significantly different from day 51 progesterone concentration. This is attributed to progesterone concentration of pregnant cows was increased as time of sampling advanced. There was also significant difference between cows in their progesterone profile. Cows with Id number 4312 and se038 were highly significant difference to Ad050 and Ax021, because these cows were loss their pregnancy and could lower progesterone profile.

Progesterone concentration of Cows suffered from embryonic mortality (figure 6) were clearly identified from those cows maintained their pregnancy in the different sample days. From the hormonost micro lab farmer's test of progesterone assay the result of the analysis indicated that 3(15%) of the cows were suffered from late embryonic mortality. After loss of their pregnancy the progesterone level drops from 26.2ng/ml to 8.6ng/ml, 27ng/ml to 11ng/ml and 22ng/ml to 5.6ng/ml for cow ID number 4312, Ax020 and Se038 respectively (Figure 6). The causes of embryonic mortality might be heat stress, nutritional factors, infectious agents, toxic substances and hormonal pattern.

10% of the embryo lose was occurred from day 27- 42 post artificial insemination and 5% after day 42(table 27 and figure 6) which is agreed with approximately 80 percent of this loss occurs before day 17, 10-15 percent between day 17 and 42 and 5 percent after day 42 (Santos *et al*, 2004). The result is consistent with the report of Humblot (2001) that evaluated embryonic losses in Holstein cows in 44 herds in France and observed that 14.7% of them were showed late embryonic death after first AI. These Pregnancy lose between 27 and 45 days after AI is in accordance with previous studies conducted by Cerri *et al*. (2003); Chebel *et al*.(2003), as well as studies conducted by others across the US (Moreira *et al*., 2001).

Out of 33 cows examined 18-24 days post insemination, in 20 (60.6%) cow's milk progesterone level was above (16 ng/ml) and the result was clearly identified as colorless (watery) table 27. These animals were assumed to be pregnant. In 13 (39.4%) cows the milk progesterone level was less than 11 ng/ml and these were considered as non pregnant (intermediate blue to deep blue color).

Among 20 cows that were assumed to be pregnant on the basis of milk progesterone concentrations (above 16 ng/ml) on day 18-24 post insemination, 17(85%) were confirmed to be pregnant examined for pregnancy through rectal examination 60 days after insemination. As the time increases accuracy of pregnancy using hormonost micro lab farmers test also increases from day18-day51 post insemination. The rest of the cows 3(15%) were showed late embryonic death from progesterone assay at day 27-33 and 45-51 post insemination (Figure 6), Because embryonic mortality is associated with declining of progesterone concentration and the color of the test becomes blue as standard estrous.

An accuracy rate of 82-88% has been reported in cows when pregnancy was diagnosed through milk progesterone levels 24 days after insemination (Heap et al., 1976). 90% of cows that were confirmed pregnant 60 days after insemination, milk progesterone levels on day 0 (insemination day) were calculated less $\leq$ 3 ng/ml. However from the 33 cows testing their progesterone level at day 0(insemination date) only 25 (75.8%) of cows were with $\leq$3ng/ml (Table 27). This result indicated that AI was probably done at the correct time, at least when the cows were without an active corpus luteum. The rest 8 (24.2%) of cows were wrongly inseminated at day of insemination.

The result in showed that the concentration of progesterone at day 18-24 in pregnant cows were higher than non pregnant cows (Figure 7). In the same fashion progesterone concentration of cows that loses their pregnancy at days of 27-33 and 45-51 after insemination drops the progesterone level and it was lower than that of pregnant animals. This result indicated that analysis of progesterone profile using hormonost micro lab farmers test were clearly identified the pregnant, non pregnant and late embryonic mortality in dairy cattle.

The use of milk progesterone tests decreased days to first AI, calving intervals, and cost per pregnancy, but the cost was greater than a blind weekly injection of PGF2α to all non inseminated animals. Although milk progesterone analysis at day of insemination will be proven the exact time of insemination AI technicians should use this new technology in their AI program.

Table 25. Least Squares Means of progesterone concentration of cows in different days

Days of sampling	N	Range	Minimum	Maximum	Mean
day18	20	14.3	14.5	28.8	21.9±0.8[bc]
Day21	20	12	18	30	23.7±0.8[ab]
day24	20	8.4	20.7	29.1	24.4±0.8[ab]
day27	20	12.5	17.2	29.7	24.3±0.8[ab]
day30	20	23.8	5.6	29.4	23.2±0.8[ab]
day33	20	18.8	11.0	29.8	22.7±0.8[ab]
day36	20	12	17	29.0	24.3±0.8[ab]
day39	20	9.6	19.8	29.4	25.6±0.8[ab]
day42	20	13.1	16.6	29.7	24.1±0.8[ab]
day45	20	20.1	8.6	28.7	25.1±0.8[ab]
day48	20	18.5	10.5	29.0	25.9±0.8[a]
day51	20	9.9	19.8	29.7	26.1±0.8[a]

Where N is number of cows taken milk sample

Table 26. Least Squares Means of progesterone concentration of cows in the study area

Cows	N	Minimum	Maximum	Mean
4224	12	17.00	29.40	24.4±0.9^{ab}
4312	12	8.60	28.40	20.9±0.9^{c}
6028	12	19.90	29.70	23.9±0.9^{bc}
Ax026	12	18.60	26.40	24.4±0.9^{ab}
6040	12	24.70	28.50	27.1±0.9^{ab}
Ax07	12	18.50	27.30	23.8 ±0.9^{bc}
4230	12	17.00	25.20	21.7±0.9^{bc}
4296	12	17.20	29.60	23.5±0.9^{bc}
Ams03	12	18.30	29.90	22.9±0.9^{bc}
Ax020	12	11.00	29.60	25.8±0.9^{ab}
Ax021	12	26.50	29.80	28.7±0.9^{a}
Ax022	12	16.00	27.30	23.6±0.9^{ab}
Se038	12	5.60	29.10	21.0±0.9^{c}
Ax025	12	21.00	27.80	25.3±0.9^{ab}
Ad056	12	19.40	29.00	24.2±0.9^{ab}
Ad050	12	24.70	29.20	27.9±0.9 ^{a}
Ad049	12	17.20	28.00	22.2 ±0.9^{bc}
Ax016	12	19.30	28.70	24.5±0.9^{ab}
Ah092	12	21.30	28.40	25.08±0.9^{ab}
Ah096	12	20.90	29.00	24.6±0.9^{ab}

Table 27. Diagnosis of pregnancy by milk progesterone assay in dairy cattle

	Days of post insemination													
	0	18	21	24	27	30	33	36	39	42	45	48	51	60
Observation	33	33	25	20	20	20	20	20	20	20	20	20	20	33
True estrus(N)	25													
True estrus (%)	75.8													
+ve PD(No)		25	20	20	20	19	18	18	18	17	17	17	17	
Confirm+ve(No)														17
Error of +ve diagnosis(No)		8	3	3	3	2	1	1	1	0	0	0	0	
Error of +ve diagnosis (%)		32	15	15	15	10.5	5.5	5.5	5.5	0	0	0	0	
Accuracy of +ve diagnosis (%)		68	85	85	85	89.5	94.4	94.4	94.4	100	100	100	100	

Milk progestrone was assyed using hormonost microlab farmers test from day18-51 after insemination. High progestrone concentration from day 18- 24 was concidered as positive, low progestrone in day 18 non pregnant and after day 24 considered as failarity of pregnancy. Genital organs are palpated per rectum at day 60 for confirming positive diagnosis, +ve=positive, -ve= negative

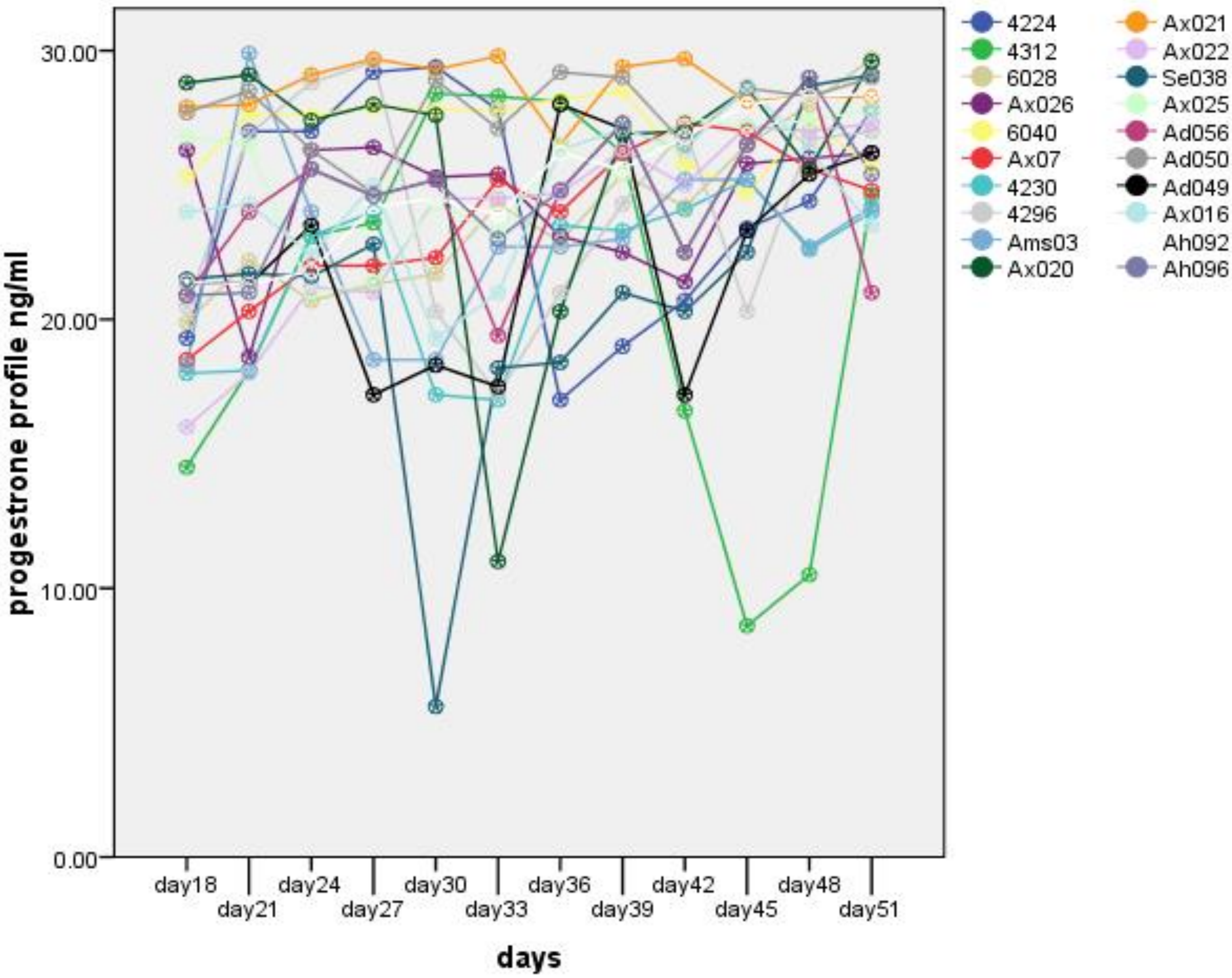

Figure 6.Patterns of Progesterone profile of cows that did or did not retain pregnancy at different days.

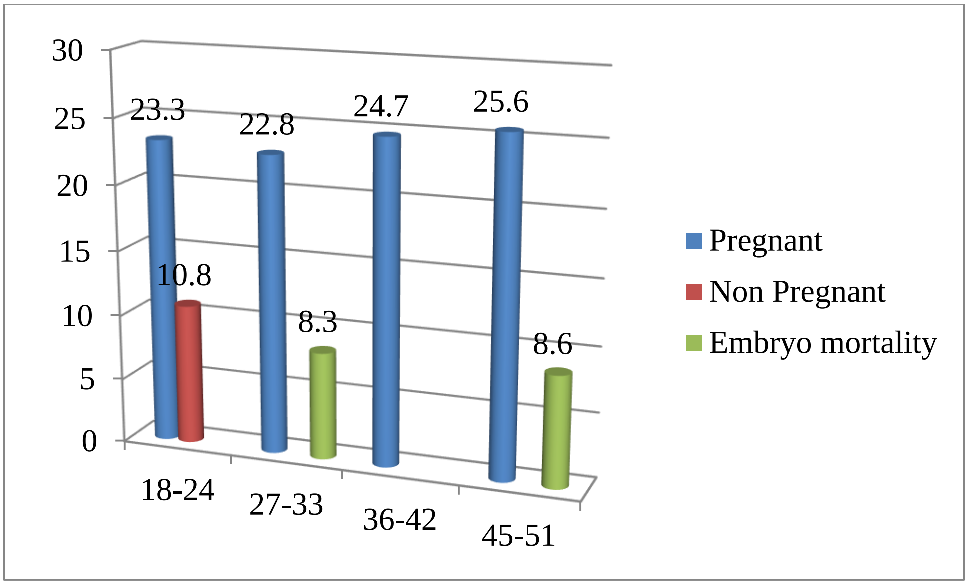

Figure 7. Level of progesterone concentration for pregnant, non pregnant and embryonic mortality at different days

5. SUMMARY AND CONCLUSION

The breeding objective of dairy cattle indicated that farmers attached greater importance to milk production for generating income and feeding the family (milk consumption) than any other stated reason. The selection criterion of famers in the study area depends mainly in milk production based on individual performance and pedigree selection (by asking the owners history of their cows). Trait preference as perceived by farmers was rated as milk yield, fertility and body weight from first to third rank, respectively. Disease resistance is the least preferred trait in the study area because disease is not a devastating problem in the area and they might be got veterinary service for treatment of their cattle. The other reason that households in the study area was gave more attention to market oriented farming system.

Artificial insemination is the dominant mating system in central zone of Tigray. Farmers in the study area also practiced AI with synchronization for the last 3 years. The opportunities for AI and synchronization of dairy production in the study area were presence of veterinary service, equipped AI technicians and experts, availability of cattle population, extension service and good market demand for milk production. During mass synchronization in central zone of Tigray there were some problems identified. Poor body condition cows, provide non cycling cows, improper semen handling starting from production until insemination, poor management, time missing for insemination (cows were inseminated at fixed time 48-72 hours) and lack of follow up were the main identified problems in the study area.

Giving second injection for cows not responded for first injection of $PGF2\alpha$ has complimentary advantage to single injection. The study also concluded that double injection of Prostaglandin has reduced the calving to service period which would eventually reduce calving interval in lactating dairy cows. In the experimental study CR and NSC were improved from 37.95%, 2.63 to 51.4%, and 1.9 respectively when comparing with the mass synchronization.

Progesterone profile analysis is very important to detect pregnancy and embryonic mortality of dairy cattle. Early identification of non pregnant dairy cows and heifers post breeding can improve reproductive efficiency and pregnancy rate by decreasing the interval between AI services and increasing AI service rate. Knowledge of embryonic mortality helps in correction of the cause of pregnancy loss in dairy cattle and consequently improves reproductive performance and profitability of small holder dairy farmers.

It is concluded that the Hormonost maicrolab farmers test technique for early pregnancy can be integrated in to AI programme in order to increase their effectiveness, reduce the unproductive period of dairy cows and increase the economic benefits to farmers.

Hormonost micro lab farmers test for progesterone profile analysis is advantageous because it is not completely dependent on the device, as the test result values can easily be assessed with the naked eye. (Trusting technology is fine, but control is better.) So if in doubt, simply examine the results with your own eyes and avoid accidental errors and gain confidence.

Recommendation

Community based breeding program by incorporating indigenous knowledge of farmers is the best option in improving breeding practice of dairy cattle in central zone of Tigray. Further work on improving smallholder farmers' awareness of the breeding and management of crossbred dairy cattle (using a participatory approach) is imperative.

Estrous synchronization can be a useful tool in the reproductive management of a cow herd. However, if proper levels of nutrition, body condition and health are not maintained, the program is likely to fail. Improvements in facilities and management may be necessary before implementing an estrous synchronization program.

To improve efficiency of synchronization appropriate selection of cows should be done. Good body condition, cyclic animal, good management and healthy, proper semen handling, AI at detected estrus and follow up after synchronization of the dairy is mandatory.

Milk progesterone test should be incorporated with AI for estrus detection, early pregnancy test and embryonic mortality. Government should gave more attention in AI programs and the hormonost micro lab farmers test shroud be purchased and available in each districts of agriculture and rural development offices for check up of heat detection, pregnancy, embryo mortality. Small scale dairy farmers can also organized in cooperatives to purchase that material.

Improvements in reproductive programs in the future will have to focus on enhancing fertilization rates and minimizing embryonic losses to optimize conception rates in dairy and beef cattle.

The study about the incidence of the embryonic death in dairy cows showed that it is a problem for cattle breeding in the study area. For achievement of higher economic results in this subject, the monitoring and correction of the various causes leading to the appearance of embryonic death are necessary.

6. REFERENCES

Abdinasir IB (2000). Smallholder dairy production and dairy technology adoption in the mixed farming system in Arsi highland, Ethiopia. PhD. Thesis, Humboldt University of Berlin, Berlin, Germany.

Abebe, O., 2009. Cattle production in high and low market access areas in the Borana pastoral system of southern Ethiopia. MSc. Thesis Presented to the College of Dry land Agriculture and Natural Resources of Mekelle University, Ethiopia.

Albert de Vries, Jessika van Leeuwen, William W. Thatcher, 2012. Economics of improved reproductive performance in dairy cattle. University of Florida, Institute of Food and Agricultural Sciences, Cooperative Extension Service, Gainesville, 32611.

Amer, HA, 2008. Estrus synchronization in high lactating dairy cows, Mljekarstvo, **58**:33 46.

Asaminew Tassew, 2007. Production, Handling, Traditional Processing Practices and Quality of Milk in Bahir Dar Milk Shed Area, Ethiopia. M.Sc Thesis School of graduate studies, Alemaya University.

Asimwe L. and Kifaro G. C., 2007. Effect of breed, season, year and parity on reproductive performance of dairy cattle under smallholder production system in Bukoba district, Tanzania. Livestock Research for Rural Development **19:** (10)

Aulakh, B S., 2008. “In vivo Sex fixing in Dairy Animals to produce female progenies”, Proceedings of the 15th congress of FAVA, pp. 243. Bangkok, Thailand.

Awet Estifanos, 2011. Past Experiences and Next Year Plan of Dairy Synchronization in Tigray. The Tigray Regional Governmental State Bureau of Agriculture, Tigray Agricultural Research Institute (TARI).

Azage Tegegn, Galal E S E and Beyene Kebede, 1981. A study on the reproduction of local zebu and F1 crossbred (European x zebu) cows. I. Number of services per conception, gestation length and days open till conception. *Ethiopian Journal of Agricultural Sciences* **3**: 1-14.

Azage Tegegne, 2003. Financing Market- oriented Dairy Development- the Case of Ada'a-Liben District Dairy and Dairy Products Marketing Association, Ethiopia. Urban Agriculture Magazine **9**:25-27.

Azage Tegegne, 2004. Urban livestock production and gender in Addis Ababa, UA-Magazine, 4, 30-31.

Azage Tegegn, Awet Estifanos, Asrat Tera, Dirk Hoekstra, 2013.Technological options and approaches to improve smallholder access to desirable animal genetic material for dairy development: IPMS Experience with hormonal estrus synchronization and mass insemination in Ethiopia.

Bebe, B.O., Udo, H.M.J and Thorpe, W., 2000. Disposal and replacement practices in Kenya's smallholder dairy herds. Proc 3rd All Africa Conference on Animal Agriculture and 11th Conference of the Egyptian Society of Animal Production.

Bebe, B.O., Udo, H.M.J., Rowlands, G.J., thorpe, W, 2003. Smallholder dairy systems in the Kenya highlands: cattle population dynamics under increasing intensification, *Livest. Prod. Sci.*, **82:** 211–221.

Belay Duguma, Yisehak Kechero and G.P.J. Janssens, 2012. Productive and Reproductive Performance of Zebu X Holstein-Friesian Crossbred Dairy Cows in Jimma Town, Oromia, Ethiopia,Department of Animal Science, Jimma University, Jimma, Ethiopia, Laboratory of Animal Nutrition, Ghent University, Merelbeke, Belgium.

Biochard, D and E. Manfredi, 1994. Genetic analysis of conception rate in French Holstein cattle. *Acta Agri.-Scandinavia. Anim. Sci.*, **44**: 138– 45

BoARD, 2013. Technological options and approaches to improve smallholder access to desirable animal genetic material for dairy development unpublished.

Buvanendran, V. & Petersen, P.H, 1980. Genotype-environment interaction in milk production under Sri Lanka and Danish conditions. Acta Agriculture Scandinavica **30**: 369–372.

Central Statistical Authority, 2005. Federal Democratic Republic of Ethiopia Agricultural sample survey. Livestock and livestock characteristics bulletin, Volume II. Addis Ababa, Ethiopia.

Cerri, R.L.A., Galvão, K.N., Juchem, S.O., Chebel, R.C., Santos, J.E.P., 2003. Timed AI (TAI) with estradiol cypionate (ECP) or insemination at detected estrus in lactating dairy cows. J. Dairy Sci. **86:** (Suppl. 1), 181(Abstract).

Cordova-Izquierdo A C A, Cordova-Jimenez M S, Cordova-Jimenez C G and Ruiz L J., 2009. "Estrus synchronization and percentage of pregnancy in dairy calves using prostaglandins by two via of administration", *Australian journal of basic applied sciences*, Vol. **3**,(3), 2834-2837. Insinet publication.

Charfeddine N., 2000. Economic aspects of defining breeding objectives in selection programmes. ciheam-iamz , Options Méditerranéennes : Série A, **43**:9-17

Chebel, R.C., Santos, J.E.P., Cerri, R.L.A., Galvao, K.N., Juchem, S.O., Thatcher, W.W., 2003. Effect of resynchronization with GnRH on day 21 after artificial insemination on pregnancy rate and pregnancy loss in lactating dairy cows. Theriogenology **60**: 1389–1399

Chochran,W.G., 1963.Sampling technique, 2nd Ed., New York: John Wiley and Sons, Inc.

Chung, A.D., Cuong, L.X., Long, V.N., Cai, D.V.,Chung, D.P. and Hai, P.H.,2001. Constraints on efficiency of artificial insemination and effect of nutrition on reproductive performance in dairy cattle smallholder farms in Vietnam. Proc. of final Research Coordination Meeting on 'Radioimmunoassay and related techniques to improve artificial insemination programmes for cattle reared under tropical and sub-tropical conditions', IAEA-TECDOC-**1220**:p. 67 –78. Vienna: IAEA.

Dailey, R.A., Inskeep, E.K., Lewis, P.L., 2002. Pregnancy failures in cattle: a perspective on embryo loss. In: Proceedings of the XVIIIth International Conference on Reproduction of Farm Animals, Slovakia, and May **30**: pp. 1–8.

Daniel Hamm & Klaus-Ingo Arnstadt, 2014. Quantitative rapid assay with the test device FertilityBox® Cow for determining the progesterone content of milk samples of dairy cows Biolab GmbH München, Alleestr. 11a, D – 85716.

Dejarnette,M., 2004. Estrus Synchronization: A Reproductive Management Tool, reproduction specialist.

Dejene Takele Gebissa,2014. Assessment of dairy cattle husbandry and breeding management practices of lowland and mid-highland agro-ecologies of Borana zone Oromia Agricultural

Research Institute, Yabello Pastoral and Dryland Agriculture Research Center, Yabello, Ethiopia, *Animal and Veterinary Sciences* **2(**3): 62-69.

Desalegn, 2008. Assessment of problems/constraints associated with artificial Insemination service in Ethiopia, Addis Ababa University Faculty of veterinary medicine.

Enyew Negussie, 1992. Reproductive performance of local and crossbred dairy cattle at Assella livestock farm. Arsi, Ethiopia, M.Sc. Thesis, Alemaya University of Agriculture. Ethiopia. 115 p. 68.

Enyew Negussie, G. Brannang and O.J. Rottman, 1999. Reproductive performance and herd life of crossbred dairy cattle with different level of European inheritance in Ethiopia. pp 65-76 In: M Proceeding of the 7th Annual Conference of Ethiopian Society of Animal Production (ESAP). 26-27 May 1999. Addis Ababa. Ethiopia.

ESAP (Ethiopian Society of Animal Production), 2002. Livestock in Food Security – Roles and Contributions. Proceedings of 9th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, August 30-31, 2001.

Ethiopian agricultural transformation agency, 2013. Innovators to help our country grow EATA, Addis Ababa, Ethiopia.

Etherington W. G , Bosu W T , Mart S W in, Cote J F , Doig P A , and Leslie K E., 1984. Reproductive performance in dairy cows following postpartum treatment with gonadotrophin releasing hormone and/or prostaglandin: a field trial. *Canadian Journal of Comparative Medicine;* Canadian Veterinary Medical Association.

Fengxum, Xu, 1997. Conception rate of cows and analysis of its correlations. *China Dairy Cattle*, **4**: 30–1.

Farin, P. W., Crosior, A. E., Farin, C. E., 2001. Incidence of *in vitro* systems on embryo survival and fetal development in cattle. Theriogenology **55**:151-170.

Fikre Lobago, 2007. Reproductive and Lactation Performance of Dairy Cattle in the Oromia Central Highlands of Ethiopia. Doctoral thesis Swedish University of Agricultural Sciences.

Fisher G.R., Kirsch J.D., Reynolds L.P., Redmer D.A., 2004. and Field valuation of milk Progesterone Kits for Determination of Pregnancy in Dairy Cows

Galon N, Zeron Y, Ezra E, 2010. Factors affecting fertility of dairy cows in Israel,J Reprod Dev,**56** Suppl: 8-14.

Gebrekidan Tesfay Weldeslasse, Zeleke Mekuriaw Zeleke and Gangwar, S.K., 2012. Reproductive and productive performance of dairy Cattle in central zone of Tigray, northern Ethiopia, Deptt. of Animal Science College of Agriculture, Aksum University, Aksum, Ethiopia, Deptt. of Animal Science College of Agriculture, Bahir Dar University, Bahir Dar, Ethiopia, Deptt. of Animal, Rangeland and wildlife Sciences, College of Agriculture, Mekelle University, Mekelle, Ethiopia, *I.J.A.B.R*., VOL. **2**(1):58-63.

Gebremedhin weldewahd and dawit weldemariam, 2013. Processes, descriptions and potential commodity interventions in central zone of Tigray.

Gebre Wold, A., M. Alemayehu, S. Demeke, S. Dediye, and A. Tadesse. 2000. Status of dairy research in Ethiopia. In The role of village dairy co-operatives in dairy development. Smallholder Dairy Development Project (SDDP) Proceeding, Ministry of Agriculture (MOA). Addis Ababa, Ethiopia.

Gitau, J.K.; O'Callaghan, C.J, McDermott, J.J, Omore, A.O., Odima, P.A., Mulei, C.M and Kilungo, J.K., 1994. Description of smallholder farms in Kiambu District, Kenya. Prev. Vet. Med. 21**-2**: 153-166.

Gokhan, D., Sariban M K, Fikret K And Ergun Y (2010), "The Comparison Of The Pregnancy Rates Obtained After The Ovysnch And Double Dose PGF2α +GNRH Applications In Lactating Dairy Cows", *Journal Of Animal And Veterinary Advances*, **9(40)**: 809-813,Medwell Journals.

Graves, M. W., 2009. Improving Reproductive Performance in Dairy Cattle. United States Department of Agriculture. National Institute of Food and Agriculture.

Graves William M., 2012. Dairy Herd Synchronization Programs. The University of Georgia and Ft. Valley State University, the U.S. Department of Agriculture and counties of the state cooperating.

Gwazdauskas, F. C., Lineweaver, J.A. and Vinson, W.E. (1981). Rates of conception by artificial insemination of dairy cattle. *J. Dairy Sci*. **64**: 358 – 62.

Gupta J, Laxmi A, Vir Singh O, and Ashutosh, 2008.A comparative study on evaluation of three synchronization protocols at field level in both cattle and buffaloes *Extension* Division Veterinary Office Dairy Cattle Physiology Division National Dairy Research Institut e, Karnal, Haryana, India.

Hla, U.T., Myatt, U.A., Kyi, D.S.S. and Win, Y.H. 2001. Improvement of cattle production in Myanmar through the use of progesterone RIA to increase efficiency and quality of artificial insemination services. Proc. of final Research Co-ordination Meeting on 'Radioimmunoassay and related techniques to improve artificial insemination programmes for cattle reared under tropical and subtropical conditions', IAEA-TECDOC-**1220**; 45–50. Vienna: IAEA.

Heuwieser, W., Oltenacu ,P.A., Lednor, A.J., Foote, R.H.1997. Evaluation of Different Protocols for Prostaglandin Synchronization to Improve Reproductive Performance in Dairy Herds with Low Estrus Detection Efficiency *Journal of Dairy Science.* Volume (80), Issue 11, November 1997, Pages 2766–2774.

International atomic energy agency, 2007. Application of Radioimmunoassay in Improving the Reproductive Management of Smallholder Dairy Cattle, Results from an IAEA Regional Technical Cooperation Project in Africa, FAO.

Ibrahim, M.N.M and Jayatileka, T.N., 2000. Livestock production under coconut plantations in Sri Lanka: Cattle and Buffalo production systems. *Asian-Aus. J. Anim. Sci.* **13-1**:60-67.

Imwalle DB, Patterson DJ, Schillo KK: Effects of melengestrol acetate on onset of puberty, follicular growth, and patterns of luteinizing hormone secretion in beef heifers. Bio Reprod **58**:1432–1436, 1998.

Inskeep, E.K., 2002. Factors that affect embryonic survival in the cow: application of technology to improve calf crop. In: Fields, M.J., Sand, R.S., Yelich, J.Y. (Eds.), Factors Affecting Calf Crop: Biotechnology of Reproduction. CRC Press, Boca Raton, FL, pp. 255–275.

James Squires E., 2003. Applied Animal Endocrinology, Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, Canada CABI.

Jordan ER, Schouten MJ, Quast JW, Belschner AP, Tomaszewski MA (2002): Comparison of two timed artificial insemination (TAI) protocols for management of first insemination postpartum. *J Dairy Sci*, **85**: 1002–8.

Khatun,M. A., bari, f.y., Shah, m. alam, Ali, m.r., sarkar, p.k., 2014. Post AI conception rate in cattle at rajarhat, kurigram, Bangladesh**.**Department of Surgery and Obstetrics, Bangladesh Agricultural Universi, Wayamba, *Journal of Animal Science – ISSN: 2012-578X; P845-P854.*

Kassie, G.T., Abduli, A., Wollny, C., 2009.valuing traits of indigenous cows in central Ethiopia, *journal of agricultural economics*, **60**(2): 386-401.

Kwaku, A. and L.P. Nkhonjera, 1986. Evaluation of the productivity of crossbred dairy cattle on smallholder and government farms in the Republic of Malawi. Research Report 12. ILCA. Addis Ababa, Ethiopia.

Kiwuwa GH, Trail JCM, Kurtu MY, Getachew W, Anderson MF, Durkin J, 1983). Crossbred dairy productivity in Arsi Region, Ethiopia. ILCA Research Report No. 11, ILCA, Addis Ababa.

Lamb G. Cliff, 2010. Estrus Synchronization protocols for cows. North Florida Research and Education Center, Marianna, Florida. Proceedings, Applied Reproductive Strategies in Beef Cattle January 28-29.

Lanyasunya, T.P., Wang, H.R., Mukisira, E.A., Abdulrazak, S.A., Ayako, W.O., 2006. Effect of seasonability of feed availability, quality and herd performance on smallholder farms in Ol-JoroOrok location/Nyandarua district Kenya, Tropical and Subtropical Agro ecosystems, **6**:87–93.

Lauderdale JW, 1975.The use of prostaglandins in cattle. Ann Biol Anim Biochim Biophys **15**:419–425.

Mayne, C.S., McCoy, M.A., Lennox, S.D., Mackey, D.R., Verner, M., Catney, D.C., McCaughey, W.J., Wylie, A.R.G., Kennedy, B.W. & Gordon, F.J., 2002. Fertility of dairy cows in Northern Ireland. *Veterinary Record*, **150**: 707-713.

Mekonnen HaileMariam and Goshu Mekonen, 1987. Reproductive performance of Fogera cattle and their Friesian crosses. *Ethiopia J. of Agric. Sci.* **9**(2): 95-114.

Mgongo F.O.K, P.Mujuni and Kitambi, 2008. Pregnancy rates of crossbred dairy cattle synchronized using GnRH and one injections of PGF2 versus two injections of PGF2 · prior to insemination. *Journal of Livestock Research and Development.* **21** (8).

Million T, J. Theingthan, A. Pinyopummin, S. Prasanpanich and Azage T., 2011. Oestrus Performance of Boran and Boranx Holstein Fresian Crossbred Cattle Synchronized with a protocol based on Estradiol benzoate or Gonadotrophin-Releasing Hormone.

Ministry of Agriculture and Rural Development, 2007. Livestock Development Master Plan Study. Phase I. Volume I. Dairy. Addis Ababa, Ethiopia.

Moreira, F., Orlandi, C., Risco, C.A., Mattos, R., Lopes, F., Thatcher, W.W., 2001. Effects of presynchronization and bovine somatotropin on pregnancy rates to a time artificial insemination protocol in lactating dairy cows. *J. Dairy Sci*. **84**: 1646–1659.

Mukasa-Mugerewa E., 1989. A review of reproductive performance of female Bos indicus (Zebu) cattle, International Livestock Centre for Africa (ILCA), monographs Addis Ababa, Ethiopia.

Murugavel, K. J.L, Yanize, P.Santolaria, M. Lopez-Bejar and F.Lopez-Gatius. 2010. Prostaglandin based estrus synchronization in Post Partum dairy cows: An update. *The international Journal of Applied Research in Veterinary Medicine.*

Mwacharo, J.M., Dracker, A.G., 2005. Production objective and management strategies of livestock keepers in south east Kenya: implication for breeding program, tropical animal health and production, **37**:635-652.

Musa LM-A, Peters K J and Ahmed M-K A, 2006. On farm characterization of Butana and Kenana cattle breed production systems in Sudan. *Livestock Research for Rural Development.* **18**:Article #177.

Nation DP, Malmo J, Davis GM, Macmillan KL. Accuracy of bovine pregnancy detection using transrectal ultrasonography at 28 to 35 days after insemination. *Aust Vet J* 2003; **81**:63-65.

National Meteorological Service Agency of Ethiopia (1996) Climatic and Agro climatic Resources of Ethiopia, volume 1, No. 1 Addis Ababa, Ethiopia.

Nebel RL, Jobst SM., 1998. Evaluation of systematic breeding programs for lactating dairy cows: A review. *J Dairy Sci* **81**:1169–1174.

Negussie Gebreslasie (2006) Characterization And Evaluation Of Urban Dairy Production System In Mekelle City, Tigray Region, Ethiopia. MSc. Thesis, University of Hawassa, Awassa, Ethiopia.

Nibret Moges, 2012. Study on Reproductive Performance of Crossbred Dairy Cows under Small Holder Conditions in and Around Gondar, North Western Ethiopia, Department of Veterinary Clinical Studies, Faculty of Veterinary Medicine, University of Gondar, P.O. Box 196, Gondar, Ethiopia.

Nordin Y, Zaini N, and Wan Zahari W.M., 2004. Factors affecting conception rate in dairy cows under selected smallholder production system *J. Trop. Agric. and Fd. Sc*. **32**(2): 219–227.

Noseir Wael MB, 2003. Ovarian follicular activity and hormonal profile during estrous cycle in cows: the development of 2 versus 3 waves. National Center for Biotechnology. Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA.

O'Connor Michael L., 2003. Estrous Synchronization programs for the dairy herd. Department of Dairy and Animal Science; the Pennsylvania State University.

Pancarci, S.M., Jordan, E.R., Risco, C.A., Schouten, M.J., Lopes, F.L., Moreira, F., Thatcher, W.W., 2002. Useof estradiol cypionate in a presynchronized timed artificial insemination program for lactating dairy cattle. *J.Dairy Sci*. **85**:122–131.

Peeler ID, Nebel RL, Pearson RE, Swecker WS, Garcia A ,2004. Pregnancy rates after timed AI of heifers following removal of intravaginal progesterone inserts. *J Dairy Sci*, ***87**:2868-73.*

Pennington, A. J., 2013. Heat Detection in Dairy Cattle. FSA 4004. University of Arkansas, Division of Agriculture. Web. United States Department of Agriculture. Institute of Food and Agriculture. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-4004.pdf.

Perera, O. ,1996. Management of reproduction. In: Falvey L and Chantalakhana C (eds) 1999. Smallholder dairying in the tropics. ILRI, Nairobi Kenya pp1-18.

Perez-Marin CC & España F., 2007. Estrus expression and ovarian function in repeat breeder cows, monitored by ultrasonography and progesterone assay. *Reprod Dom Anim*; **42**: 449-456.

Pierson RA, Ginther OJ.,1987. Follicular populations during the estrous cycle in heifers: 1. Influence of day. *Anim Reporod Sci*.; **124**:165–176. doi: 10.1016/0378-4320(87)90080-7. [Cross Ref].

Peixoto, M.G.C.D., Verneque, R.S., Teodoro, R.L., Penna, V.M., and Martinez, M.L, 2006. Genetic trend for milk yield in Guzerat herds participating in progeny testing and MOET nucleus schemes. *Genet. Mol.,* **5**: 454–465

Purohit G., 2010. Methods of Pregnancy Diagnosis In Domestic Animals: The Current Status. Web med Central Reproduction; **1**(12):WMC001305 *Webmedcentral.*

Pursley JR, Mee MO, Wiltbank MC. Synchronization of ovulation in dairy cows using PGF2α and GnRH. Theriogenology 1995; **44**:915-923.

Randel, R.D., 1990. Nutrition and postpartum rebreeding in cattle. *J. Anim. Sci.* ***68:*** 853–62

Rege, J.E.O., 1998. Utilization of exotic germplasm for milk production in the tropics Proc. 6 World Cong. On Genetics Applied to Livest. Prod. **25**:193-200

Rao, A. R. N. and R. M. H. Rao, 1996. The life time milk production breeding efficiency of Jersey cows in Andhra Pradesh. *India. Vet. J*. **73**:480-483.

Rick Rasby and Gene Deutcher, 2013. Synchronizing Estrus In Beef Cattle. University of Nebraska–Lincoln | Lincoln, NE 68588 | 402-472-7211.

Santos, J.E.P., Thatcher, W.W., Chebel, R.C., Cerri, R.L.A., Galvão, K.N., 2004. effect of embryonic death rates in cattle on the efficacy of estrus synchronization programs Animal Veterinary Medicine Teaching and Research Center, University of California—Davis,18830 Road 112, Tulare, CA 93274, USA, Department of Animal Sciences, University of Florida, Gainesville, USA *Reproduction Science* **82–83**: 513–535.

SAS, 2003. SAS User's Guide: Statistics. Ver.9.1. Cary, NC: Statistical Analysis System Inc.

Shamsuddin, M., Bhuiyan, M.M.U., Sikder, T.K., Sugulle, A.H., Chanda, P.K., Alam, M.G.S. and Galloway, D., 2001. Constraints limiting the efficiency of artificial insemination of cattle in Bangladesh. Proc. of final Research Co-ordination Meeting on 'Radioimmunoassay and related techniques to improve artificial insemination programme for cattle reared under tropical and subtropical conditions', IAEA-TECDOC-1220, p. 9–27. Vienna: IAE .
Silvia, W. J., 1998. Changes in reproductive performance of Holstein dairy cows in Kentucky from 1972 to 1996. *J Dairy Sci.* **81**(Suppl. 1):244 (Abstr.).

Solomon L, 2006. Characterization of market oriented small holder dairying and performance evaluation of dairy cooperatives in Dejen District Amhara Region. M.Sc..Thesis. Hawassa University, Awassa, Ethiopia.

Snedecor, G.W. and Cochran, G.W., 1967.Statistical methods,6th Edn. The IDWA state University press.

Stein,J.,Ayalew,W.,Rege,J.E.O.,Mulatu, W., B., Dessie,T.,Phlipsson,J.,2009.livestock keepers perception of four indigenous cattle breeds in tsetse infested areas of Ethiopia, tropical animal health and production,**41**:1335-1346.

Stephen B. Blezinger, 2000. Estrous synchronization a valuable tool in management of cows and heifers. Cattle Today, Inc.

Tenhagen BA, Drillich M, Heuwieser. W, 2000. Synchronization of lactating cows with prostaglandin F2alpha: insemination on observed oestrus versus timed artificial insemination. J Vet Med Assoc **47**:577–584.

Tenhagen, B.-A., 2004**.** Clinic for Reproduction, Section of Production Medicine and Quality Management, Free University of Berlin, 14163 Berlin, Germany.

Tesfaye Mengsitie, 2007. Characterization of cattle milk and meat production, processing and marketing system in metema district, Ethiopia. M.sc. Thesis, Hawassa University, Ethiopia.

VanDerWerf, J.,2004. An overview of animal breeding programs. Online: http://www.genome.iastate.edu/edu/QTL/Julius_notes/01_intr.PDF. Accessed 14th July.

Van der Werf Julius, 2006. Optimizing design of breeding programs

Venkata Ramana K, Rao KS, Supriya K and Rajanna N, 2013. Effect of prostaglandin on estrus response and conception rate in lactating ongole cows, *Vet World* **6**(7):413-415, doi:10.5455/vetworld.413-415.

Watts TL, Fuquay JW, 1985. Response and fertility of dairy heifers following injection with prostaglandin F2a during early, middle or late diestrus. Theriogenology **23**:655:661.

Williams SW, Stanko RL, Amstalden M, Williams GL. 2002. Comparison of three approaches for synchronization of ovulation for timed artificial insemination in Bos indicus-influenced cattle managed on the Texas gulf coast. Animal Reproduction Laboratory, Texas A&M University Agricultural Research Station, Beeville 78102-9410, USA.

Yitaye Alemayehu Ayenew (MSc), 2008. Characterization and analysis of the urban and per-urban dairy production systems in the North western Ethiopian highlands, University of Natural Resources and Applied Life Sciences, Vienna.

Young, IM: Selection of specific categories of dairy cows for oestrus induction with dinoprost. Vet Rec 113:319–320, 1983.

Zegeye Yigezu, 1976. The effect of age, breed, and days open, stage of lactation and on daily body weight and milk weight in lactating dairy cattle. M.Sc. Thesis. Univ. of British Colombia, Canada.

Zelalem Yilma and Ledin Inger, 2001. Milk production, processing, marketing and the role of milk and milk products on smallholder farmers' income in the central highlands of Ethiopia. pp. 139-154. In: Proceedings of the 8th Annual Conference of the Ethiopian Society of Animal Production (ESAP). 24-26 Addis Ababa, Ethiopia.

Zemenu Yayeh1, Mekonen Hailemariam2, Kelay Belhu3 and Bimrew Asmare, 2014. Characterization of dairy cattle production systems in Debremarkos district, Amhara Regional State, Ethiopia , **2(4):** 42-51.

7. APPENDIXES

Appendix 1**.**Questionnaire used to collect information from dairy farmers

Enumerator Name---

Wereda-- kebele--

Name of interviewee--sex_________age________

Annex 1.1. General information

1. Agro ecology of the area --

   1=Highland   2=mid altitude   3=Low land

2. Household classification (production system) ---------------------------------

   1=Rural   2=Urban   3=Per- urban

3. Total Number of HH Member

	Age group						Educational level			
	<2	2-10	11-15	16-30	31-50	>50	Illiterate	1-7	7-12	>12
Male										
Female										
Total										

4. Land holding in ha

	Purpose	Own(ha)	Rented (ha)	Communal (ha)
1	Crop (including fallow land)			
2	Grazing & Forage production			
3	Irrigated land			
4	Other			
5	Total			

4.1 What was the trend of land holding for the last five years? -------------------------

   1= Increasing   2= No change   3=Decreasing

5. Livestock resources & Utility

5.1. Number of livestock by type sex & age

	Livestock Type	Breed type		Total	Most important species
		Local	Cross		
1	Calves (< 1 yr age)				
2	Heifer				
4	Bull				
5	Oxen				
6	Dry cow				
7	Lactating cow				
8	Sheep				
9	Goat				
10	Equines				
11	Poultry				
12	Beehive				

Annex 2. Breeding practices

6. What is your major farming activity? ----------------------------------

1= Livestock production 2= Crop production 3= Mixed type of production

7. Purpose/objectives of keeping dairy cattle?

1. Milk consumption 2. Generating cash income 3. Breeding 4.other

8. Milk production of dairy cattle

No	Breed	Amount of milk per cow per day in liter	Lactation period	Milking frequency/day
1	Local			
2	Cross			

9. What is the source of feed provided to your dairy cattle? Rank them according their use

____

____

10. What is the source of water for dairy cattle?

1. Pond/dam 2.river 3.pipe water 4. Rain water

11. The distance of watering point to dairy from village

1. Watered at home 2. <1km 3. 1-5km 4. 6-10km

12. Do you clean the house of the dairy cattle?

1. Yes 2. No

13. If your answer is yes, write the frequency of cleaning?

1. Daily 2. Weekly 3. Monthly

14. Have you faced any animal health problem so far in your dairy herd? 1. Yes 2. No

15. If your answer is yes, what problems

1. Mastitis 2. Tuberculosis 3. Problems associated with calving

4. 1&2 5. 1&3 6. All of the above 7. Others__________________

16. Do you have veterinary service in your area?

1. Yes 2. No

17. If your answer is yes, how far from your home?

1. <1km 2. 1-5km 3. 6-10km 4. >10km

18. What is/are your selection criteria for dairy breeds? How do you prioritize the criteria?

____

____

____

19. Which type of breed do you prefer for dairy production?_________

1. Local 2. Holstein crosses 3. Jersey

20. Trait preference of farmers for dairy cattle

No	Traits	Rank
1	Body weight	
2	Fertility	
3	Milk yield	
4	Feeding behavior	
5	Market value	
6	Color	
7	Disease resistance	

21. Where do you obtained foundation dairy stock

1. Purchased 2. Gift 3.upgrading 4. Own

22. Which mating system do you use? Why?

1. AI with estrus synchronization 2. AI only 3. Natural mating

____

____

____

23. if your answer to the above question is AI, how do you communicate with AI technicians?

1. AITs visit us dial
2. We call AITs when we need them
3. We take our cows to the AI station

24. Do you get AI service on weekends and holidays? 1. Yes 2. No

25. If your answer to the above question is no, what do you do?

1. Pass the date without breeding the cow 2. Use NM

26. If your cows do not conceive with repeated t inseminations, then what do you do?

A. use AI again and again B. use NM

27. Do you have any say in the selection of the type of semen you use?

1. Yes 2. No

28. Are you aware of the problems of inbreeding?

1. Yes 2. No

29. If your answer is yes, give examples____

30. Are you satisfied with the overall AI service? 1. Yes 2. No

31. If you can be provided with reliable and regular service, would you mind raising the service charge? 1. Yes 2. No

32. How do you evaluate the AI technician in giving you the service?

1. Cooperative 2. Non-cooperative

33. What are the signs of estrus you use in order to report your cows for AI service?

____

____

34. In relation to the above answer, what do you do if the AIT comes too late for insemination?

1. Get the service any way 2. Reject the service and wait for another 21 days 3. Use NM 4. Do not know

35. How much, do you pay for insemination? ------------------------------?

36. Do you think the existing insemination fee is fair? --------------------------------------

1=Yes 2= No

37. Have you faced failure of insemination? ---

1=Yes 2= No

38. If yes how many times? ---

1=One 2=Two 3=Three 4= More than four

39. What do think the reason for the failure?

No	Variables	Priority
1	Heat detection problem	
2	AI technician efficiency	
3	Distance of AI centre	
4	Absence of AI technician	
5	Disease problem	
6	Other	

40. If your answer to the Que. 20 is AI with synchronization, what is your perception in estrus synchronization in your area? Why?

1. Low 2.Medium 3. Good 4.Very good

____
____
____
____.

41. If you use bull (natural service) service, from where do you get the bull?

1. Own 2. From village 3. From neighboring

42. Do you castrate your bull?

1. Yes 2. No

43. If your answer is yes, why?

____
____
____

44. Do you have a record or keep the performances of your breeding cattle?

1. Yes 2. No

45. If yes, list the type of records

____
____
____

46. What are the opportunities and constraints of AI and synchronization in your area?

____
____
____
____
____

47. Age at first calving of your cow is? Local_______ Cross______

48. Calving interval of your cow is? Local_______ Cross_______

49. Days open of your cow is? Local____________cross_________

50. How long is the reproductive life of a breeding cow ________________?

51. Sexual maturity of your breeding bull___________________________?

52. How long is the reproductive life of the male cattle__________________?

53. Do you have any plan to improve the reproductive performance of your dairy herd?

1) Yes 2) No

54. If yes, how do you improve the reproductive performance of your dairy herd?

____

Appendix 2. Questionnaire used to collect information from Artificial insemination technicians

Woreda-- kebele--
Name of AIT--sex_________age__________

Please answer the following questions precisely:

1. When did you start your career as AIT?

   1. 1968-1978 2.1979-1988 3. 1989- 1998 4. 1999-2008

2. Where did you attend your training as AIT?

   1. Assela 2. NAIC 3. Region

3. For how long did you attend your training as AIT?

   1. 6 months 2. 3 months 3. 9 months 4. 2 months

4. How do you evaluate the quality of training?

____

____

5. What is the method of service delivery?

____

____

6. Do you get on- the- job trainings and other incentives?

____

____

____

7. Is there any other technician in your area?

   1. Yes 2. No

8. If your answer to the above question is no, what happens in case you are not available due to some reasons?

   1. Service discontinues 2. Farmers use NM

9. Where do you get semen?____

10. In relation to the above question, do you face any problem while obtaining semen?

1. Yes 2. No

11. Do you provide services on weekends and on holidays? 1. Yes 2. No

12. If your answer to the above question is no, why not?

____

____

____.

13. How do you judge the overall availability of inputs including liquid nitrogen and other consumables?

14 Do you think the NAIC is carrying out its responsibilities properly?

1. Yes 2. No 3. I do not know

15. Who does decide the type of semen/bull to be used by you for inseminating?

____

16. Do you think there is a proper mechanism of controlling indiscriminate insemination?

1. Yes 2. No 3. I don‘t know

17. Do farmers report on time for inseminations?________________________________

18. Are farmers willing to pay more for the services provided they get reliable and quality services?

1. Yes 2. No 3.don't know

19. How do you judge the quality of semen you are getting?

____

20. Do you get the necessary support by the BoARD and wereda agriculture office to the AI service? 1. Yes 2.no

21. Do you generally believe that AI is doing well in your area? If no, Why?

1. Yes 2.No 3. I do not know

____

___

22. What is the average number of cows you are covering per day?

1. 1-10 2. 11-20 3.21-30 4.31-40

23. What radius in kilometers do you cover daily to deliver the service?

1. 1-20 2. 21-30 3.31-40 4. >40

24. In relation to the above answer, is the distance being covered convenient for proper application of the service?

1. Yes 2. No

25. Which transportation system do you use?

1. stationed 2. On foot 3. Motorbike 4. Car

26. Is AI service delivery consistent in your area? If no why?

1. Yes 2.No

27. Do you have estrus synchronization service in your area? ---------------------

1= Yes 2=No

28. If yes, what is your perception in estrus synchronization in your area?

1. Low 2.Medium 3. Good 4.Very good

29. If your answer is low what do you think lowering the result in estrus synchronization?

____

____

____

____.

30. What is the average number of cows you are covering per day in synchronization? ______________

31. What are the opportunities and problems of AI and estrus synchronization in your area?

____

____

____

____

32. Do you have any idea on how to improve the breeding practice in the future?

Appendix 3. Questionnaire presented for focus group discussion

Enumerator Name--
Woreda-- kebele--
Name of interviewee---

1. What are the husbandry management practices in your area?

____
____
____

2. Where is the source of your breeding stock?____

3. Trait preference of farmers for dairy cattle

No	Traits	Rank
1	Body weight	
2	Fertility	
3	Milk yield	
4	Feeding behavior	
5	Market value	
6	Disease resistance	
7	Color	

4. Which type of breed of dairy cattle is suitable for your area? Why?

____
____
____
_

5. Is the semen obtained from NAIC believed to be of the desired quality?

____

6. Is there any control mechanism employed in your region to evaluate semen for quality? in terms of health, reproduction, etc?

____

7. Is it important to have a national breeding policy in place soon to assist the AI service? Why?

8. Is there a proper mechanism of controlling indiscriminate inseminating?

9. Is AI doing well in your area in general terms?

10. Which mating system do you think is better? Why?

11. Is the AI service a success in your area?

12. What are the major problems and opportunities associated with AI and estrus synchronization in your area in particular and in the country in general?

13. Do you select bulls for breeding purpose? If yes How?

14. Is there any idea on how to improve breeding practice in the future?

Appendix 4. Group discussion with farmers

Appendix 5. Data record sheet for estrus synchronization

No.	Name of farmers	kushet	Tabia	Wereda	Animal ID	Breed	Age	Parity	BCS	Corpuslut eum	Date of injection	Cervix status	inseminat ion date	Bull no.	PD
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															

Appendix 6. Data record sheet for progesterone profile of lactating dairy cattle

ID No.	Week 1				Week 2				Week 3				Week 4			
	Day 18	**Day 21**	**Day 24**	**Mean**	**Day 27**	**Day 30**	**Day 33**	**Mean**	**Day 36**	**Day 39**	**Day 42**	**Mean**	**Day 45**	**Day 48**	**Day 51**	**Mean**

Appendix 7.Analysis of variance of livestock holding in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Calf					
Production system	1	2.82737346	2.82737346	4.53	0.0341
Breed	1	0.00000000	0.00000000	0.00	1.0000
Prods*breed	3	5.87056458	1.95685486	3.17	0.0245
Error	357	222.9948488	0.6246354		
Corrected error	359	225.8222222			
CV= 57.30					
Heifer					
Source of variation					
Production system	1	0.04597807	0.04597807	0.14	0.7102
Breed	1	0.40000000	0.40000000	1.20	0.2734
Prods*breed	3	0.68314622	0.22771541	0.68	0.5619
Error	357	118.6540219	0.3323642		
Corrected error	359	119.1000000			
CV= 24					
Bull					
Source of variation					
Production system	1	1.15856154	1.15856154	4.21	0.0408
Breed	1	4.66944444	4.66944444	16.98	<.0001
Prods*breed	3	5. 7.21 95442735	1.98480912	7.21	0.0001
Error	357	98.1692162	0.2749838		
Corrected error	359	103.9972222			
CV= 31.8					
Oxen					
Source of variation					
Production system	1	8.53451364	8.53451364	18.80	<.0001
Breed	1	85.06944444	85.06944444	187.40	<.0001
Prods*breed	3	97.51516349	32.50505450	73.17	<.0001
Error	357	162.0599308	0.4539494		
Corrected error	359	255.6638889			
CV= 14.3					
Dry cow					
Source of variation					
Production system	1	0.03106921	0.03106921	0.12	0.7335
Breed	1	3.40277778	3.40277778	12.71	0.0004
Prods*breed	3	3.62669727	1.20889909	4.51	0.0040
Error	357	95.54115301	0.26762228		
Corrected error	359	98.97500000			
CV= 19.30					

Cont…

Lactating cow					
Source of variation					
Production system	1	0.61529557	0.61529557	2.40	0.1222
Breed	1	0.13611111	0.13611111	0.53	0.4667
Prods*breed	3	1.80054191	0.60018064	2.36	0.0711
Error	357	91.51248221	0.25633749		
Corrected error	359	92.26388889			
CV= 32.2					
Poultry					
Source of variation					
Production system	1	2.9620679	2.9620679	0.32	0.5746
Breed	1	232.9214473	232.9214473	24.82	<.0001
Prods*breed	3	257.2433276	85.7477759	9.17	<.0001
Error	355	3332.077820	9.386135		
Corrected error	357	3568.192737			
CV= 57.30					

Appendix 8. Analysis of variance of daily milk yield of dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	133.811671	133.811671	26.24	<.0001
Breed	1	1244.439424	1244.439424	244.05	<.0001
Prods*breed	3	1402.783071	467.594357	91.70	<.0001
Error	208	1060.595172	5.099015		
Corrected error	211	2463.3782431			
CV=15					

Appendix 9. Analysis of variance of lactation length of dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.9985412	0.9985412	0.12	0.7248
Breed	1	175.5399416	175.5399416	21.85	<.0001
Prods*breed	3	177.2699292	59.0899764	7.36	<.0001
Error	208	1670.856250	8.032963		
Corrected error	211	1848.126179			
CV= 34.58					

Appendix 10. Analysis of variance of calving interval of dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.00265282	0.00265282	0.01	0.9085
Breed	1	5.62044867	5.62044867	28.08	<.0001
Prods*breed	3	5.69625354	1.89875118	9.48	<.0001
Error	205	41.03896104	0.20019005		
Corrected error	208	46.76555024			
CV= 29.18					

Appendix 11. Analysis of variance of age at first calving of dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.95763443	0.95763443	1.39	0.2402
Breed	1	40.30414840	40.30414840	58.40	<.0001
Prods*breed	3	51.32641422	17.10880474	24.62	<.0001
Error	204	140.8001063	0.6901966		
Corrected error	207	190.8991827			
CV= 23.03					

Appendix 12. Analyses of variance of days open of dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	3.4944798	3.4944798	0.12	0.7280
Breed	1	826.9858431	826.9858431	28.70	<.0001
Prods*breed	3	852.9921615	284.3307205	9.84	<.0001
Error	205	5906.712931	28.813234		
Corrected error	208	6754.631579			
CV= 57.30					

Appendix 13. Analysis of variance of reproductive life of local dairy cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.68837803	0.68837803	0.18	0.6761
Error	172	676.1851852	3.9313092		
Corrected error	173	676.8735632			
CV= 17.62					

Appendix 14. Analysis of variance of reproductive life of local male cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.13016674	0.13016674	0.57	0.4532
Error	118	27.11774993	0.22981144		
Corrected error	119	27.24791667			
CV= 6.72					

Appendix 15. Analysis of variance of age at maturity of local male cattle in the study area

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Production system	1	0.35460050	0.35460050	2.82	0.0960
Error	118	27.11774993	0.22981144		
Corrected error	120	15.11261261	0.12593844		
CV= 8.91					

Appendix 16. Analysis of variance for progesterone profile

Source of variation	DF	Type III sum of squares	Mean square	F value	P >F
Cows	19	973.5581250	51.2399013	4.30	<.0001
Days	11	365.0721250	33.1883750	2.78	0.0021
Error	209	2490.785375	11.917633		
Corrected total	239	3829.415625			
CV =14.22					

Appendix 17. Time of response for heat after PGF2α treatment in single and double injection

Time of response	N	Minimum	Maximum	Mean	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Single	107	48.00	96.00	69.3925	1.34275
Double	17	48.00	96.00	57.8824	3.59931